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ABSTRACT

An orientation to management information systems (MIS) is offered which presents information about MIS in the context of public education and suggests some considerations that should be taken into account in designing and operating such systems. MIS is defined as a set of operating procedures that act as a control system to automatically provide information assistance to decision-makers, but that are separate from any particular technology. A system framework for MIS is presented which takes into account PPBS (Planning-Programming-Budgeting Systems), PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), decision trees, and fault tree analysis. Components of MIS are discussed--the data element, the personnel element, the display element, equipment element, and programing element. Steps in developing a MIS--requirements, design, production, installation, and operations--are identified. Descriptions are provided of some applications of MIS for general administration, curriculum design and review, personnel evaluation, and research and development in instruction. The role of computers in MIS is discussed in terms of their place in the total system framework. (JY)

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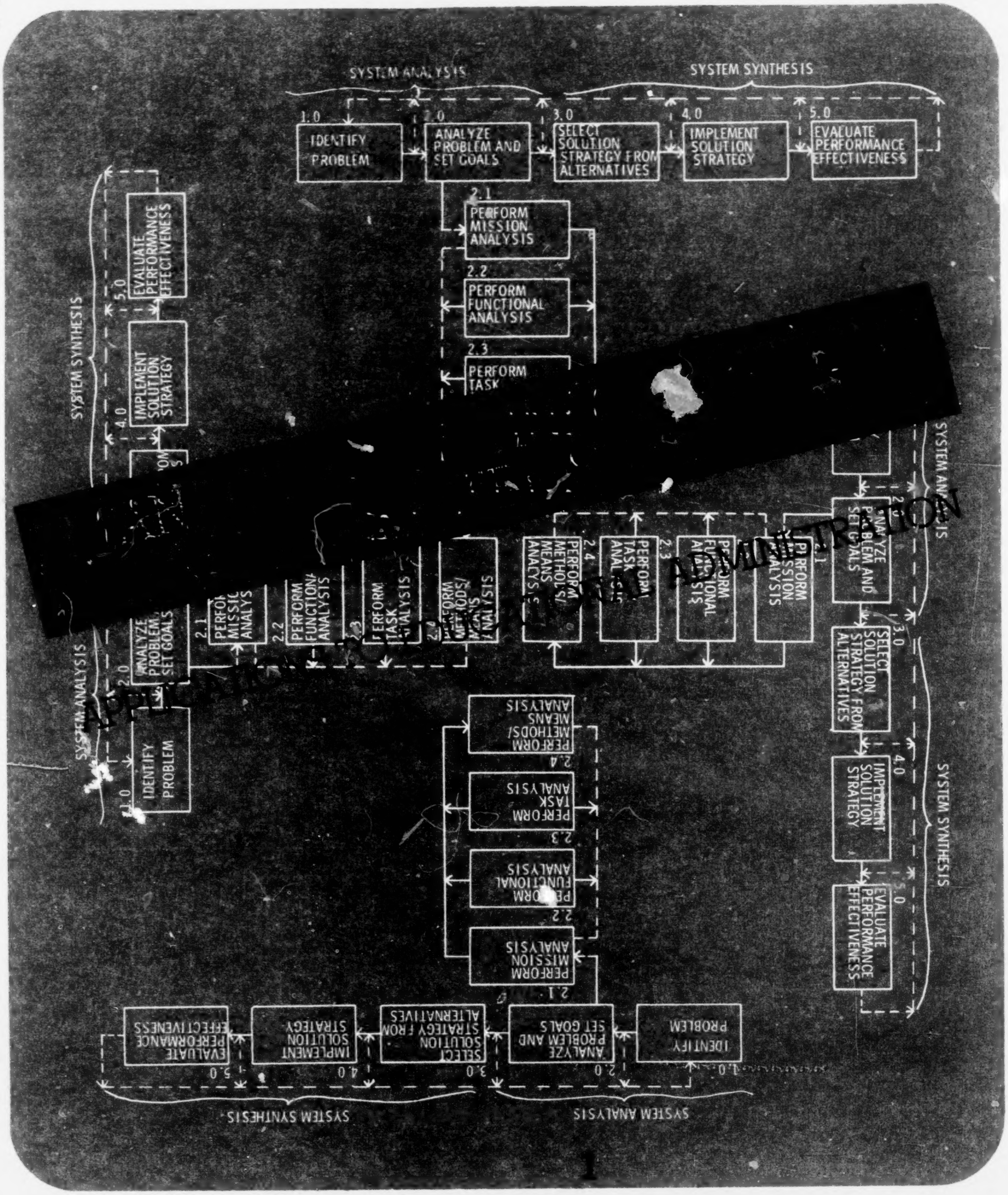
SYSTEM ANALYSIS
SYSTEM SYNTHESIS
1.0 IDENTIFY PROBLEM
2.0 ANALYZE PROBLEM AND SET GOALS
3.0 SELECT SOLUTION STRATEGY FROM ALTERNATIVES
4.0 IMPLEMENT SOLUTION STRATEGY
5.0 EVALUATE PERFORMANCE EFFECTIVENESS
2.1 PERFORM MISSION ANALYSIS
2.2 PERFORM FUNCTIONAL ANALYSIS
2.3 PERFORM TASK ANALYSIS
2.4 PERFORM METHODS/ MEANS ANALYSIS

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APPLICATIONS TO EDUCATIONAL ADMINISTRATION

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MANAGEMENT INFORMATION SYSTEMS:
APPLICATIONS TO EDUCATIONAL ADMINISTRATION

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1971

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

1.1 Purpose and plan of the paper 1

1.2 Definition and functions of MIS 2

1.3 Need for MIS 5

2.0 SYSTEM FRAMEWORK FOR MANAGEMENT INFORMATION SYSTEMS 7

2.1 Basic concepts of system analysis 7

2.2 Planning-Programming-Budgeting Systems (PPBS) 16

2.3 PERT/CPM - network-based management procedures 26

2.4 Decision Trees and Fault Tree Analysis 33

2.5 Relationship of MIS to PPBS, PERT, Decision Trees, and Fault Tree Analysis 41

3.0 COMPONENTS OF MIS 44

4.0 STEPS IN DEVELOPING AN MIS 49

4.1 General considerations 49

4.2 Phase I. Requirements 51

4.2.1 Analysis of data in the present system 52

4.2.2 Analysis of processing elements in the present system 55

4.2.3 Specifications of system task requirements 57

4.3 Phase II. Design 58

4.4 Phase III. Production 61

4.5 Phase IV. Installation 61

4.6 Phase V. Operations 64

4.7 Summary 64

Page

5.0 EXAMPLES OF MIS IN EDUCATION 67

5.1 General administration and management 67

5.2 Curriculum and instruction 75

5.3 Certificated and pupil personnel 78

5.4 Research and development in instruction 79

6.0 THE ROLE OF COMPUTERS IN MIS 83

7.0 CONCLUSIONS 90

APPENDIX -- Figures referred to in text 99

1.0 INTRODUCTION

1.1 Purpose and plan of the paper

With the explosion of knowledge and the rise of computer technology, educators are faced with the decision as to whether they should invest in data processing systems, and if so, what kind. This is starting at the wrong end of the problem. The real problem today for educational managers, that is, administrators at various levels within the school systems, is to have a system whereby they can get the information they need for decision-making. It is the purpose of this paper to provide an orientation as to what is meant by management information systems in the context of public education, and to suggest some considerations that should be taken into account in designing and operating such systems.

Management Information Systems (MIS) cannot be fully understood outside the context of system analysis. Although it is beyond the scope of this paper to explain the system approach in detail, enough background is provided to supply the basic concepts, so that the student may have a framework for further study.

The bibliography includes not only technical works on MIS and related topics, but also many training materials developed specifically for educators which are not found in college libraries. Many of the sources cited are pamphlets that were developed by the staff and consultants of Operation PEP (See Section 2.0 below). Although the program has now been phased out, it should be possible to obtain copies of the publications from the San Mateo

1.1 Purpose and plan of the paper

County Superintendent of Schools. These materials and others listed, formerly available through the Alameda County *PACE Center which has now been phased out, can be ordered from the Curriculum Library of the Alameda County School Department, 224 West Winton Avenue, Hayward 94544.

The most complete treatment of MIS (excluding books that focus primarily on computers) is found in Rosove's book, Developing Computer-Based Information Systems. This paper draws liberally from several chapters in that book, translating the application from business and the military to educational settings.

The material that follows is intended to be a guide to the student of educational administration who is interested in significant new developments in management and decision-making. The point of view throughout is that MIS is much more than data processing, and that the computer is only one tool in the context of network-based management procedures.

1.2 Definition and functions of MIS

The term Management Information Systems (also sometimes called Executive Information Systems, or Educational Information Systems) is not synonymous with Educational Data Processing (EDP), although MIS may use automated data processing equipment. Data processing equipment of various kinds is often used in school systems for accounting purposes, or simply to speed up many recording and reporting procedures which were formerly done manually. Such use does not in itself constitute an MIS.

---

*Projects to Advance Creativity in Education (PACE) was one of 21 regional planning and evaluation agencies in California funded under ESEA Title III. All PACE Centers and/or county offices have PEP publications as well as others related to MIS, PPBS, etc.

1.2 Definition and functions of MIS

The following definitions provide a conceptual framework:

> ...*A set of operating procedures* which personnel carry out to *acquire needed information from* appropriate sources, process the data in accordance with a preprogrammed rationale, and present them to decision-makers in a timely, meaningful form. *(1, p. 372)
>
> An information system is the formal or rationally planned means whereby managers receive and transmit information. Hence, it is more than an automatic data processing system. It may include automatic data processing as one aspect of the information-handling apparatus, assisting management, but it may also include oral briefings. Every large man-made enterprise depends upon and has an information system of some kind. It is essential to differentiate between an information system as such and the particular technology which, in a given time and place, is utilized as one feature of the system. This is important because there is a tendency to classify types of systems by technological characteristics rather than by the characteristics of information systems. (29, p. 4)
>
> Any formal system of procedures established to provide useful, symbolic information in the planning and decision making processes of management is an MIS. . .MIS is not a distinct, single process. It is any type of control system that provides informational assistance to administrators, and it can be used to supplement the program budgeting process. (16, pp. 37-38)
>
> The means whereby managers receive and transmit information are aggregates of the people and equipment that:
>
> 1. Are linked at least in part by two-way communication;
> 2. Are necessarily interdependent in operation;
> 3. In operation are under the control of an organization of people whose actions are prescribed to some extent;
> 4. Characteristically receive, transform, transmit data which are instrumental in accomplishing the purposes of the manager. (29, p. 97)

---

*Numbers in parentheses refer to the numbered references in the bibliography at the end of the paper.

1.2 Definition and functions of MIS

> An MIS integrates the dynamic functions of an organization, such as instruction, personnel, and finance, and provides computer-aided systems of information control for administrators; it may be a reporting system, or a decision-making system, depending on level of application. (16, p. 255)
>
> Information is the concept relating data which are otherwise meaningless to some specified human purpose or objective. From this point of view, 'data processing' is a set of activities which transforms data into information. This distinction between data and information emphasizes what needs to be stressed. It focuses attention on the uses we intend to make of data, rather than upon data-processing tools as such. (29, p. 3)

Rosove gives an example of a radar operator in a system of air defense who was tracking an unidentified aircraft. The operator regards radar returns from clouds as noise, not information; but to a meteorologist attempting to forecast weather, radar returns from clouds are not noise, they are the information he needs to achieve his objectives.

According to Jaffe, information systems can have only three objectives: to communicate, to process data, and to control environment and resources. (29, p. 119) Hartley states that the three basic functions of MIS are the collection, processing, and distribution of data. (16, p. 38) Neither of these statements goes far enough in terms of the use or value of the data. A more comprehensive statement is: "The major objectives of an information system are to bring relevant data in useable form to the right user at the right time, so that they will help in the solution of the user's problems." (29, p. 94)

Rosove points out that information is different from data. A datum is a fact in isolation. Information is an aggregate of facts so organized,

1.2 Definition and functions of MIS

or a datum so utilized as to be knowledge or intelligence. Information is meaningful data, whereas data as such have no intrinsic meaning or significance. (29, p.3, emphasis added)

Another important distinction that must be made is that between management information and descriptive information.

> Descriptive information broadly tells about an on-going enterprise, that is generally not related to specific policies, objectives, and priorities. For example, a report on the allocation of federal funds to various occupational categories of training would be descriptive material. Management information, on the other hand, would compare those allocations with the level of job opportunities in the various occupational categories. (22, p. 151)

1.3 Need for MIS

Hartley points out the reasons for MIS:

> Administrative conduct and policy execution are dependent upon the information available to the officials of the school system. In a sense, information is a system's life blood. Data for general administrative purposes may be collected from all of the sources in the school system and transmitted to a central processing point where they are transformed into information. (16, p. 187)

Other uses of MIS are stated by Bolton:

> Information is useful to several aspects of the decision process other than predicting consequences of alternatives; it is useful for evaluating prior decisions, for describing a changing environment and the constraints that exist within it, for determining institutional and personal values, and for convincing others of the efficacy of choices. It may be as important to obtain information for these latter purposes as for predicting consequences. (2, p. 9)

1.3 Need for MIS

Following are typical kinds of information that educational managers need, to make decisions or to improve their systems:

1. Reallocating scarce resources in order to get the most effectiveness for the time, money, and personnel available.
2. Information on instructional accomplishments of various populations within a system in order to know whether goals and objectives are being met.
3. Reporting by exception, so that in effect a warning light can be flashed when something within the system is not operating properly.
4. Providing pupil personnel information of the type that can assist with guidance and counseling, both for the personal development of the student and to assist the student in making career decisions.
5. Information on what happens to students after they exit from the school system. Such follow-up studies need to have data coming in quickly enough and routed effectively enough so that the information can be used for the purposes of curriculum change where necessary.

There are also data processing chores which can and should be accomplished by a computer simply because they can be done faster. In a way, these are part of the information process; but they are not so much for the use of decision makers as they are for the dissemination of information to various people within and without the school system. For example, payrolls and accounting procedures, making out report cards, compiling test information, scoring, etc., are all functions which can be accomplished by computers. However, unless these functions are also integrated into a total system, they may turn out to be more costly and inefficient in the end. In a word, the total information needs of the school system must be thoroughly analyzed to show where the various types of functions fit in and how they can best be accomplished.

2.0 SYSTEM FRAMEWORK FOR MANAGEMENT INFORMATION SYSTEMS

2.1 Basic concepts of system analysis

A management information system is a system--that is, it is composed of various interacting and interrelated components, some of which may be people, some of which may be printed data of various kinds, and other components such as hardware. A computer alone is not an information system and no decisions about installing or using a system can be made on the basis of simply buying hardware to process data. System analysis supplies the framework for understanding any MIS, and management information systems are at the heart of such system developments as PPBS and PERT.

The literature on system analysis has become so voluminous that the subject will not be covered in detail here. In 1966, a special statewide training program for California educators, Operation PEP (Preparing Educational Planners), was funded under Title III of the Elementary and Secondary Education Act to teach the application of system analysis to educational planning and management. The project was phased out in June, 1970, after training hundreds of administrators and producing a number of publications. (See publications by Corrigan, Kaufman, Miller, Eastmond, Cook, Evans and Varney.)

System analysis has been defined as "an orderly way of identifying and ordering the differentiated components, relationships, processes, and other properties of anything that may be conceived as an integrated whole. In a system two or more parts and their relations form a single, identifiable entity." (16, p. 23) System analysis provides a basis for the intensive study of complex phenomena that are in some way related within the defined boundaries of a unified system.

A fairly widely accepted definition is: "A system is a set of objects together with relationships between the objects and between their attributes." Another is, "The sum total of separate parts working independently and in interaction to achieve previously specified objectives." (20, p. 419)

Hartley summarizes the characteristics of a system as follows:

1. A system is a set of entities together with their properties and the relationships between the entities.
2. The entities that make up a system may be viewed as given to man or constructed by man.
3. The entities of a system are a variety of parts.
4. Properties of entities are their specifications.
5. Relationships of entities are connections between entities.
    a. In static relationships, the properties of entities do not change with time.
    b. In dynamic relationships, the properties of entities change with time.
    c. Environment is a set of all entities that surround the system and whose action may affect and be affected by the system. It is also referred to as the suprasystem.
    d. The boundaries of a system are the regions that differentiate the system from the environment. (16, p. 41)

2.1 Basic concepts of system analysis

The properties of systems are stated thus by Hartley:

1. A system is a multisystem if it has other systems (subsystems) as its entities.
2. A system is open if it has input and output.
    a. Input is the sending of entities from the environment into the system
    b. Output is the sending of entities from the system into the environment.
3. A system is regulated if it has feedback. Feedback is the return of output to the system.
4. A system is adaptive if exchanges between the system and its environment lead to continuance of the system.
5. A system is stable if change in certain system variables remains within definite limits.
6. A system is compatible with its environment if it survives.
7. A system has wholeness if a change in any entity of the system affects change in all other entities and affects a change in system action.
8. A system has independence if a change in at least one entity of a system affects that entity alone and does not affect change in system action.
9. A system is degenerate if it has independence in relation to all its entities. (16, pp. 41-42)

Fig. 1

Kaufman (20) defines a system approach in terms of a problem-solving sequence. The basic model for his system approach to education consists of the following steps: (1) identify the problem, (2) analyze the problem and set goals, (3) select solution strategy from alternatives, (4) implement solution strategy, (5) evaluate performance effectiveness.

2.1 Basic concepts of system analysis

Fig. 2

Problems are derived from identified needs. A "need" has been defined as "the discrepancy between *what is* and *what is required*." (20, p. 415) A need, then, is a measurable difference or distance between a present state or condition and what is required to be accomplished.

This definition has formed the basis for many of the new models of needs assessment in California that have been developed in the past four years by PACE Centers. (It should be noted that when many people talk about *needs* they are really talking about *solutions*. For example, administrators, when asked to list their most pressing needs, often reply that they need more money, or newer buildings, or more teachers. These are actually *means* to solving some problem growing from needs which may not be precisely defined. As an instance, a typical discrepancy, hence need, might be that 5th grade children in District X have a mean reading score on a mandated test which is 20 percent below the state norms. The solution *might* involve more money or more teachers, or it might not.)

The *problem* is then defined as the requirement to reduce the discrepancy to a specified level. System analysis as a problem-solving method consists of applying specified steps as a process to arrive at an appropriate solution.

Certain aspects of the systems approach should be noted. The criteria (or performance requirements) for acceptable solutions to a problem are identified and defined in operational or measurable terms. The system planner also states his objective in measurable terms, so that it will be quite clear when the objective has been achieved. He analyzes the limits and constraints, attempting to be as realistic as possible, and yet allowing for flexibility in reaching a solution.

One of the important characteristics of the systems approach is that the planner seeks out and examines many alternative solutions to the problem. He then examines each solution strategy in the light of the performance requirements he has set up, taking into due consideration the limits and constraints. He must analyze the resources available for solving the problem, including the possibility of reallocating existing resources by eliminating or changing other aspects of the system. The solution strategy decided upon may not be ideal, but it has been arrived at by a logical, objective process which has built-in safeguards, if used properly.

Another important characteristic of the systems approach is that the planner uses feedback from each step in the system to make corrections as necessary. He thus does not lose sight of his objective or of the criteria for an acceptable solution. Information gathered from any step in the process may necessitate rethinking one or more previous steps, which in turn, alters subsequent steps and leads to better solution strategies and implementation plans. In effect, this constitutes an on-going evaluation of the process and of the products at each stage of the approach.

A number of steps in accomplishing system analysis have become standard among educational planners. These steps include: (1) mission analysis, (2) functional analysis, (3) task analysis, and (4) methods-means analysis.

2.1 Basic concepts of system analysis

Only a very brief description of these tools will be given here, based principally on the work of Kaufman and Corrigan in Operation PEP. Although different system analysts use somewhat different wording and may put in somewhat different steps, the logic and general method are similar.

Fig. 3

(1) Mission analysis includes the statement of the overall mission objective (that is, what has to be accomplished), identifying the specific performance requirements or criteria needed for satisfactory completion, and specifying a central path or mission profile needed for achieving a valid solution to the problem. The mission analysis gives the overall management plan necessary for getting from the state of what is to what is required.

(2) Functional analysis consists of breaking down the mission profile into its component functions. It specifies each of the steps in the mission profile on a vertical expansion.

(3) To identify the units of performance, one performs a task analysis. Each of these three types of analysis--mission, functional, and task--differ from each other in degree rather than in kind. Various types of functional flow block diagrams are used to depict these stages.

(4) The last step in system analysis is called methods-means analysis. This step identifies the possible strategies for each performance requirement or group of them, and the means that might be used for accomplishing them.

2.1 Basic concepts of system analysis

Method-means may be identified at any stage in the system procedure, with a listing of the advantages and disadvantages of each, and in practice may be continually refined.

Fig. 4

All four steps in system analysis identify what is available, not how to accomplish the mission. The procedure provides data for selecting and implementing the most effective solution strategies. Thus, it can be seen that information is a basic requirement of system analysis, and that, in fact, the process provides an objective, orderly method for identifying data needed, finding data sources, selecting relevant data, organizing it as information, and making decisions based on the analysis.

Figs. 5 & 6

Problem-solving, using a systems approach, is not complete with system analysis alone. The process of system synthesis includes the steps of selecting the most appropriate and feasible solution strategy, implementing it, determining performance effectiveness, and finally, revising and correcting as required.

Fig. 7

2.1 Basic concepts of system analysis

Taken together, system analysis and system synthesis provide a management tool for planning and implementing educational innovations. While in itself system analysis does not constitute a management information system as such, no MIS in the true sense can be developed and installed without a sound basis in system analysis. The foregoing discussion has been a very simplified one. Actually, system analysis can be used on a simple or highly sophisticated basis to deal with the complex problems facing education today.

One motivation for the use of more sophisticated planning procedures is that educators wish to exert control over the future of their schools instead of merely reacting to events and being controlled by them. As Hartley points out, however, an important question facing school officials today is not _whether_ system analysis should be used in the schools and universities, but _how_ it can be used more effectively. The systems approach consists of a number of planning, procedural, and allocation strategies which originated in industry and the federal government. Hartley notes four major areas of application of system analysis in education: (17, p. 516)

AREA		ACTIVITY	EXAMPLE
1. Policy formulation	-	Strategic Planning	*PPBS
2. Management	-	Administrative Execution-Control	MIS
3. Instruction	-	Learning and Evaluation	**CAI
4. Research	-	Pure and applied projects	***PERT

Another activity which might be listed under both management and research is process evaluation and monitoring, with the relatively new tool of Fault Tree Analysis as an example. The uses of PPBS, PERT, and FTA will be discussed in Sections 2.2, 2.3, and 2.4.

---

*Planning-Programming-Budgeting System

**Computer Assisted Instruction

***Program Evaluation and Review Technique

2.1 Basic concepts of system analysis

Hartley, who is strongly committed to the systems approach, has felt it necessary to call attention to some of the major limitations of systems procedures for education. He feels that they fall under three categories: (1) conceptual--problems of theoretical definition; (2) operational--problems of administrative execution; and, (3) societal--problems of environmental relevance. He lists 25 limitations, not in order of priority: (17)

- Confusion over terminology
- Problems in adapting models
- A wisdom lag
- Illusions of adequacy by model builders
- Inadequate impetus from states
- Centralizing bias
- Unanticipated increased costs
- Goal distortion
- Measuring the unmeasurable
- Cult of testing
- Cult of efficiency
- Defects in analysis
- Accelerating rate of social change
- Spread of institutional racism
- Political barriers
- Conventional collective negotiations procedures
- Lack of orderliness for data processing
- Monumental computer errors
- Shortage of trained personnel
- Invasion of individual privacy
- Organizational strains
- Resistance to planned change
- Antiquated legislation
- Doomed to success
- Imagery problems

Hartley concludes that the success of system procedures depends upon the artistry of the user. In this connection, it should be noted that administrators are not necessarily the best analysts, nor should they be. Administrators, as educational managers, need to be able to use the data and information from system analysis to make decisions, and therefore, should be familiar enough with the tools to know when they are needed and their limitations as well as possibilities. As various systems approaches prove their worth in education, there should emerge trained people, with an analytical bent, who can use systems procedures as part of planning and management teams. At the present time in California, school districts often rely on PACE Centers, or on members of private consultant firms. Many of the latter are more oriented to business or engineering than to education.

A final point is that system analysis and synthesis do not necessarily require computers for application. The analytic process itself is mainly one of conceptualization, and is best done by small groups of people working together with input coming from a variety of sources. There are complex mathematical models available which require computers to handle the data. But computer data processing itself should not be confused with system analysis, MIS, PPBS, etc.

The basic model of a system is also the model for an information system. The MIS's collect, synthesize, process, transmit, and display information which flows from a primary source, through an editing, computation, and selection process to the manager.

Figs. 8 & 9

2.2 Planning-Programming-Budgeting Systems (PPBS)

The concept of PPBS in education has developed in the last few years from a number of sources. Chief among these might be considered the growing demand on the part of legislatures and the public for "accountability" for student performance. Leon Lessinger, former Associate Commissioner of Elementary and Secondary Education, has stated:

> Local educational agencies must develop the capacity to renew themselves and to be more responsive to the changing needs of their clientele. They have demonstrated success in expansion and elaboration of existing programs in response to national concerns, but need to develop the capacity to manage the problems of continuous renewal and flexibility.

> This implies the development of a new kind of educational management that concurrently (a) involves clientele in the definition of needs and policies, (b) brings real authority to bear upon solution to problems, and (c) institutionalizes change.

Lessinger goes on to say:

> Extension or expansion of services of local and state agencies is laudable but inadequate: they must be accountable for the learning results they produce with public funds. Schools for too long have operated as public monopolies and have been able to avoid the consequences of poor or mediocre performance. Student unrest is merely one consequence of these inadequacies. (14)

PPBS has been variously described as a tool for public policy decision making, a method of allocating scarce resources in order to achieve maximum cost/effectiveness, and a way of relating the activities of an organization to specific resources that are then stated in terms of budget dollars. The word program does not refer to computer programming, but designates the activities of an organization that are based upon desired outcomes. It should be pointed out that PPB systems encompass more than program budgeting. In the confusion of terminology and methodology that has occurred in the last three or four years in education regarding PPBS, it would be well for educators to note that the process begins with planning, and that it is perhaps a wider and more comprehensive application of system analysis to educational planning and management than heretofore.

The evolution of PPBS in California might be described briefly by noting four stages: (1) In 1961, the Rand Corporation and the Department of Defense used program budgeting for cost control. (2) In 1965, federal agencies under President Johnson were put on PPB systems in order to exercise executive control. (3) In 1967, the California legislature set up the State Advisory Commission on School District Budgeting and Accounting, for the purpose of providing better information for decision making and cost control. Finally, (4) in 1968, PPBS was implemented on an experimental basis with eight pilot school districts throughout California.

The pilot stage of implementation was continued in 1969-1970 with a total of fourteen school districts and one county school office. The firm of Peat, Marwick, and Mitchell was retained to put on workshops, develop a model for PPBS in education, and assist the pilot school districts in implementing the first stages of that model. A manual with the description of the model and the results obtained so far was due to be released in the summer of 1970, with further steps toward implementation taken in 1970-71.

Fig. 10 shows that in one conceptualization, a management information system is at the heart of PPBS.

Fig. 10

In this model, information comes from three major sources: (1) A multi-level informational setting, (2) statements of goals and objectives of the system, arranged in hierarchies in order to give priorities, and (3) the tools of system analysis. In this concept, PPBS is action-oriented toward the achievement of specific goals. Reporting requirements from the multi-organizational level might come from a school district, the county school office, the state department of education, the U.S. Department of Education, and a variety of public agencies at the city, county, state, or federal level. The information from these organizations, their goals, and system analysis lead to both short and long range plans for action.

The model that has been developed in California under the Advisory Commission on School District Budgeting and Accounting includes the following:

Goals
Objectives and evaluative criteria
Programs
Program Structures
Program Codes
Program Budget
Multiyear Financial Plan
Program Expenditure Accounts
Program Reports

Fig. 11

The following definitions are taken from the Conceptual Design for PPBS by Peat, Marwick, Mitchell & Co. (7). Further definitions and examples of goals and objectives are found in a pamphlet published by the California School Boards Association (11).

> A goal is a statement of broad direction, purpose, or intent based on the identified needs of the community. A goal is general and timeless; that is, it is not concerned with a specific achievement within a specified time period.
>
> Objectives are desired accomplishments which can be measured within a given time frame. Achievement of the objective advances the system toward a corresponding goal. Accordingly, objectives must be developed that support and contribute to the achievement of the established goals.
>
> A program is a group or package of interdependent, closely related services or activities progressing toward or contributing to a common objective or set of allied objectives.

2.2 Planning-Programming-Budgeting Systems (PPBS)

> A program structure is a hierarchial arrangement of programs which represents the relationship of activities to goals and objectives. The structure contains categories of activities with common output objectives.
>
> Program Codes - Programs are coded by number to facilitate the collection of data such as costs and statistics in a variety of combinations and formats consistent with the program structure. These data are used to control program expenditures, evaluate program effectiveness in terms of stated objectives, and to analyze the cost/effectiveness of alternative programs.
>
> The program budget in a PPBS is a plan that relates proposed expenditures for programs, within a specific time frame, to goals and objectives, based upon a program structure classification. It includes the proposed revenue sources for financing programs.
>
> The Multiyear Financial Plan (MYFP) presents financial data for existing and alternative programs projected for a period of several years. (7)

Fig. 12 shows the relationship between goals, objectives, and planning strategies for various time spans in a PPBS context.

Fig. 12

One of the salient features of an analysis of the activities of school districts under PPBS, as contrasted with traditional ways of looking at these activities, is that a program may cut across departmental lines and the traditional school district organization and structure.

Fig. 13

2.2 Planning-Programming-Budgeting Systems (PPBS)

As a matter of fact, one of the reasons for instituting PPBS at the federal level was that the existing government organizations had programs which overlapped, and in some cases, duplicated the efforts of other agencies. An example is that funded programs for research in vocational education can be found in the Department of Labor, and in several branches of HEW--the Career Opportunities Branch of the U. S. Office of Education, as well as the Research Coordinating Unit of the Department of Vocational Education, and the former Bureau of Research itself (now the National Center for Educational Research and Development). Similar overlapping and concomitant lack of communications occurs at the state level as well.

A somewhat different conceptualization of the aspects and tasks involved in PPBS can be found in Fig. 14.

Fig. 14

Here the various stages in planning, programming, and budgeting are broken down into the structural aspects, the analytical aspects, and the information system aspect. It will be seen that the information system aspect has considerable overlapping with the analytical aspect, which is in effect a system analysis. Particularly important is the use of an adequate information system for evaluating the alternatives and updating the program through feedback from the operation of constituent parts of the program.

Another important feature of PPB systems is the use of multi-year financial plans based upon program budgets. Program budgets are a radical departure from the traditional line item budgets now used by school districts and county offices.

In program budgeting, every cost factor is allocated to some activity which is a part of a program which, in turn, supports a clearly specified objective. In a comprehensive program budget, both direct and indirect costs, including supportive and maintenance services, would be allocated throughout, so that the actual cost of any given program or portion thereof can be determined. Cash flows for each program by months can also be determined.

Fig. 15

But it is not enough to know how much a program cost last year or may cost in the coming year. A really good program budget will break down the cost into categories such as development, implementation, and operation, and project these same costs for each program up to at least five years. This is necessary in order to make decisions relating to growth and expansion, changes, reallocation of resources, innovations, and the like. It may be that a program with high developmental costs would, in the long run, pay for itself because of low implementation and operation costs, and relatively high effectiveness for each dollar spent. Conversely, school districts sometimes make the decision to install programs of low initial cost, only to find that in the long run the program costs more per unit of effectiveness than had been anticipated.

2.2 Planning-Programming-Budgeting Systems (PPBS)

The exact form of a program budget is not as important as is the philosophy of PPBS. The cost/benefit, cost/effectiveness, and cost/utility analyses are also of little use unless they are tied in with clearly defined learning and instructional objectives which are based upon societal and educational values of importance.

Considerable anxiety and concern has arisen among educators in the last two years since the state legislature has been stressing accountability, and it seems probable that PPBS will be mandated for school districts in California within the next two to three years. The sheer amount of work and the money involved in a time of rising costs and lessened financial support for the schools is of legitimate concern. However, it is not the problem of program budgeting which should be tackled first, but rather the setting of goals and objectives. The school districts which have begun this process have found that it is a lengthy and difficult one. If it is to be done properly with the most relevant input for decision making, then it should be a cooperative process between educators (both administrators and teachers), school boards, various sectors of the community, and even students. Suggestions for the planning and programming aspects which would meet the best criteria for public policy decision making can be found in a series of pamphlets developed by Operation PEP.

Fig. 16

2.2 Planning-Programming-Budgeting Systems (PPBS)

It is not the intent here to discuss PPBS in detail, as much has been written on the subject and new books and articles are coming out constantly. PPBS models developed in California under the pilot program are available on request from Sacramento. (Dr. James Waters is Executive Secretary of the State Advisory Commission on School District Budgeting and Accounting.) Hartley also gives a number of examples, not only from California, but from New York, Pennsylvania, Baltimore, Chicago, Memphis, Philadelphia, and Seattle. His examples are heavily oriented toward the budgeting aspects, but his book constitutes a good overview of PPB systems. (16)

It is interesting that some states now call it PPBES, the "E" standing for evaluation. In the view of this writer, this is a tautology, as every step of PPB systems involves evaluation through feedback, monitoring, and control.

When a PPB system is fully implemented, it will be absolutely necessary to have a comprehensive management information system at the heart of it. Information of various kinds must be constantly assembled, organized, analyzed, and interpreted, in order to keep the structure flexible and responsive to new or changing demands. This information may relate to costs of programs, to the degree to which various instructional objectives are being achieved, to the relative effectiveness of various organizational and staffing structures and practices, to the use of time and space in relation to program objectives, and to the impact of various programs on the community.

2.2 Planning-Programming-Budgeting Systems (PPBS)

It will also be necessary for much more effective follow-up studies of students to take place, with constant information being fed back to the schools, probably on a regional basis. One of the most obvious applications of this is in information that should come to the schools regarding the employment of students after leaving high school, or their entry into apprenticeship programs, junior colleges or four year colleges, and the successful completion of those programs. At the present time, very few school districts have adequate information of this sort, and in many districts that have done large scale studies, the interpretation of the data has taken so long that the studies have not been effective for management decisions. Moreover, although students in the San Francisco Bay Area, for example, enter the job market as well as colleges in the entire Bay Area, there is no system presently available for collecting and analyzing the data on a regional basis, so that the data base is comparable from one district to another, and so that trends can be anticipated as needed for planning and management.

The rise of PPBS in educational planning and management is in line with an important trend in education--that is, the traditional concepts of school administration are giving way to modern concepts of network-based management systems. As school systems have become larger and more complex, it has become apparent that some of the network management procedures which have been used in industry might be profitably adapted for school management. While these are related to PPBS, they can also be used individually for any program or project in education. Some of these techniques will be discussed in the next two sections.

2.3 PERT/CPM - network-based management procedures

The network approach to planning is a major advance in improving management planning and control effectiveness. It is designed specifically to deal with the accelerated pace of today's development programs, and the uncertainties associated with them. As noted before, the decision making process requires increasing amounts of data of all kinds, both qualitative and quantitative, with the result that it has been necessary to look for new aids to sound decision making. Although no management tool in itself can make decisions, some of the tools of network planning can provide the basis for a realistic and economical management information system which will permit more informed decisions to be made.

The use of the term "management" instead of "administration" has been used frequently throughout this paper. That is because the trend in school administration is toward more informed decision making on the part of school officials rather than just the maintenance and operation of an existing organization. It has been stated that decision making is synonymous with managing. It is the purpose of network management systems to supply information to the manager in a timely, useful, and understandable manner.

Figs. 17 & 18

An excellent overview of a number of these concepts is contained in the book by Archibald and Villoria. (1) Although the discussion is mainly from the standpoint of business management, applications are possible to education. The authors point out that there are, in general, three kinds of management information systems: product related, operations related, and administration related. In general, management information systems in education are administration related--that is, the systems involve non-technical information related to providing the organizational, financial, manpower, material, and facilities resources needed to carry out the functions of education at the appropriate time and place and by the appropriate methods.

Network management tools have evolved from a number of much simpler procedures. Although these have been used in industry, engineering, and the military for many years, they are relatively new to education.

One of the oldest of these techniques is the Gantt chart, which was invented by Henry Gantt around 1900. The Gantt chart is a series of bars plotted against a calendar scale. Each bar represents the beginning, duration, and end in time of some segment of the total job to be done, or activity to be accomplished, and together the bars make up a schedule for the whole program.

An example of its application to education is the requirement for Gantt charts to be included in proposals for ESEA Title III projects in California. Each activity related to each of the objectives of the project is to be broken down into units which show the elapsed time by months for that activity.

Fig. 19

While the Gantt chart is a useful tool for gross planning, it does have a number of weaknesses. The chart cannot show interdependencies among activities, it is inflexible and cannot reflect changes in plans or "slippages" in the system, and it is unable to reflect uncertainty or tolerances in the duration of the estimated times. However, it is a considerable improvement over the mere listing of activities which often constitutes the total management plan of a project or a program.

An improvement over the Gantt chart was the milestone chart, which specifies the key events or points in time which can be identified as the program progresses. It is oriented to *events*, rather than to the duration of *activities*. In milestone charts, the lists of tasks and milestones are displayed on charts adjacent to a time scale. The milestone chart has been used extensively in the military and industry for the management of major weapon systems programs prior to the advent of PERT. Two forms are shown.

Figs. 20 & 21

Even though this was an improvement, there were some limitations, notably the fact that the relationship between milestones was still not established. Milestones were listed in chronological sequence, but not related in a logical sequence, and there was no display of *interrelationships*.

Although computers could be used for sorting and listing information on milestone charts, they were not used as effectively as might be until the advent of PERT and CPM. In 1957 the DuPont Company began an investigation of the extent to which a computer might be used to improve the planning and scheduling, re-scheduling, and progress reporting of the company's engineering programs. This resulted in a system known as the Critical Path Method, which used a unique arrow diagram, or network method.

At the same time, the Special Projects Office of the U. S. Navy was faced with the management of the POLARIS--a huge, complicated weapons system development program, which was conducted at, or beyond the state-of-the-art in many areas, with activities proceeding concurrently in hundreds of industrial and scientific organizations in different areas. What emerged was the Program Evaluation and Review Technique (PERT) which was an integrated management planning and control technique. Fig. 22 shows the evolution of both CPM and PERT, as given in Archibald and Villoria's book. (1, p. 15)

Fig. 22

It is important to notice some differences between the two techniques. In general, CPM was developed when the elements were:

1. Well defined projects
2. One dominant organization
3. Relatively small uncertainties
4. One geographical location for a project

CPM, which is an activity type network, has been widely used in the process industries, in construction, and in single project industrial activities. (1, p. 14)

The PERT network (event network) evolved from a combination of bar charts and milestone charts, on which milestones were identified as special events, or particular points in time, which were of interest to management. The environmental factors were considerably different from those which influenced the development of CPM:

2.3 PERT/CPM - network-based management procedures

> 1. Massive programs with hard to define objectives
> 2. Multiple and overlapping responsibility divided between organizations
> 3. A large degree of time and cost uncertainty
> 4. Wide geographical dispersal and complex logistics
>
> The PERT technique has proved most applicable to large scale research and development, and systems engineering programs, and in other industrial activities involving a large degree of uncertainty, such as new product development and marketing. (1, pp. 14-15)

Fig. 23

Buckner has shown how PERT activity networks can be derived directly from functional flow block diagrams. (3, pp. 19 & 22)

Fig. 24

An excellent "do it yourself" book by Desmond Cook is also available (8). PERT charting is time consuming and somewhat complex, and should not be used for the management of repetitive programs which are fairly well established in schools. It is, however, useful in the management and control of new projects, such as those for ESEA Titles I, III, VI and VII. Particularly when a considerable amount of development is to take place and where there is uncertainty as to the amount of time and resources needed to accomplish these activities, it can be useful to construct PERT diagrams in order to be able to allocate the resources to the best advantage.

2.3 PERT/CPM - network-based management procedures

An example is in the development of new materials for a program which must also include teacher inservice, and testing out in the classroom. A PERT chart can show the interrelationship among the planning and development activities, the secretarial services needed, the use of consultants, and the building of facilities or the production of materials in quantity. A good analysis, for example, may reveal the fact that a given objective cannot be accomplished in the time that was anticipated unless additional clerical help is provided at a certain time. Since the activities needed to accomplish the events can also be tied to costs, alternate solutions or strategies can be PERT-ed to show the relative feasibility in relation to cost of various strategies. For a good explanation of this see Desmond Cook (8).

An important concept in PERT is that it is possible to define the critical path, that is, to find the path among all of those in the network that will consume the most time in reaching the end event. By isolating this particular sequence of activities, the manager derives some of the most vital information he needs to plan and manage the program properly. The network also is able to handle uncertainty in the program plans because it estimates a range of duration times from the most optimistic to the most pessimistic for each activity in the network plan.

The use of PERT is valuable as a management information system because it controls the quantity, type, and format of vital information needed for the manager from one program level to another. The PERT network can and should be modified as slippages and changes occur in the duration of the activities leading to the events. Information from the network can then be used to make decisions regarding when resources will be required and how resources might be reallocated if necessary to best achieve the objective.

Some analysts suggest that if PERT is to be used at all, it should constitute the principal and perhaps the entire management information and control system to be used. This prevents the accumulation of data in unrelated forms and for unrelated purposes. While it would not be feasible to base an entire school MIS on PERT network planning, it certainly could be used for a self-contained project that might be instituted in a school, such as that operated under a particular state or federal program. Once the program has been tested and put into operation as part of the on-going system, however, other management information systems should be used.

Finally, in systematic planning for any network system, the following questions should be answered:

1. What are the project objectives?
2. What are the major elements of the work to be performed, and how are these elements related to one another?
3. Who will be charged with the various responsibilities for accomplishing project objectives?
4. What organization of resources is available or required?
5. What are likely information requirements of the various types and level of management to be involved in the project? (1, p. 23)

2.4 Decision Trees and Fault Tree Analysis

While the network tools discussed in the foregoing section apply particularly to project planning and development, an increasingly important use of network planning techniques, both in industry and in education, is in the evaluation of existing systems and procedures, with a view to monitoring and possible redesign. These techniques are extended to introduce structure and logic into the decision making process, and to assist managers and policy making bodies in making long range choices from among alternatives.

One such tool which has been used effectively in industry is the decision tree. This is used when an organization must make decisions about future plans based on incomplete information. The theory is that no decision operates in isolation or even under a simple sequence. It is assumed that any decision made at any time will be influenced by events that have happened in the meantime, and that it is possible to anticipate a number of alternative results at each decision point based on varying events.

A simplified decision tree can be drawn to show the alternatives as to whether a cocktail party should be held indoors or out. There are two choices possible: to hold it outdoors or indoors. There are two possible weather events to take into consideration also: rain and no rain. The results of each of these events as related to each of the two choices can then be depicted as in Fig. 25. (1, p. 333)

Fig. 25

2.4 Decision Trees and Fault Tree Analysis

Decision trees have not been widely used in education, but the technique offers many possibilities when used with MIS. For instance, a decision tree might be built to anticipate the results of building two different types of high schools in a school district: (1) a third comprehensive high school in addition to the two which are presently existing, and (2) a vocational-technical high school. The tree might look like that shown in Fig. 26.

Fig. 26

The decision as to which school is to be built can then be based on the analysis of such data as the percentage of pupils who have exited from the high schools directly onto the job market within the last five years from that district, the relative costs of the two schools, the cost of vocational programs in comprehensive schools as compared with vocational schools, the character of the population and analysis of population trends for the area, and the relative probabilities of high, medium, and low average demands for vocational-technical education. By analyzing the impact of various future events on each type of school in various stages of time and at given decision points, decision makers can make more informed judgments regarding the type of school to be built. Also involved, of course, are qualitative judgments having to do with values related to the tracking and academic segregation of students, and other matters which do not relate to costs in the financial sense. The impact of these can also be charted, however, and should certainly be taken into consideration in future planning.

2.4 Decision Trees and Fault Tree Analysis

As Peter Drucker has expressed it, "Long range planning does not deal with future decisions. It deals with the futurity of present decisions." (1, p. 342) In other words, today's decision should be made in the light of the anticipated effect which it and the outcome of uncertain events will have on future values and decisions. Industry has combined the use of decision trees with forecasts of demands, market analysis, and financial and other evaluations of programs in order to provide more objective data to evaluate alternatives. Monte Carlo techniques and Bayesian statistics have also been used, but will not be discussed here.

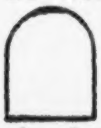
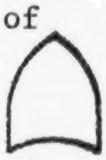
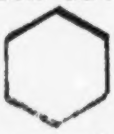
The final network concept to be presented here, which is related somewhat to decision trees, is that of Fault Tree Analysis (FTA). Fault Tree Analysis is a technique for increasing the probability of success in any system by analyzing the most likely modes of failure that could occur. It is an operations research tool which has been used with signal success as the principal analytical tool of systems safety engineering on aerospace projects. (35)

The fault tree was so named because the completed graphic portrayal of a functional system utilizes a branching process analagous to the development of a coniferous tree. The undesired event is located at the apex, and the various contributing events are the branches that extend outward and down. A fault tree, also called an "event logic network," provides a concise and logical step-by-step description of the various combinations of possible occurrences within a system which might result in a predefined "undesired event." It is a diagram which traces systematically the probable mode of failure leading to the undesired event, the interaction among those modes, and the critical paths.

Fig. 27

Fault Tree Analysis cannot be performed outside the context of a systems approach. Before FTA can take place, the following steps must be taken: analyze the system, identify the pertinent subsystems and elements, and bound the system for purposes of analysis. The process of FTA starts with a statement of a critical undesired event which one wants to prevent happening in the system. The fault tree is then constructed by a series of inputs to logic gates, which specify at each stage precisely how a given failure event can occur. (In this context, "failure" means the inability of a system or portion of a system to perform its expected function(s).)

Fig. 28

An important function which is performed by Fault Tree Analysis is the depicting of the interrelationships among events. This is done by means of logic gates, the most common of which are the AND gate:  OR gate:  and INHIBIT (or conditional) gate: . Events are depicted by various shapes, such as rectangles, circles, and diamonds, to show the source of the event or its degree of development in the analysis.

2.4 Decision Trees and Fault Tree Analysis

As an example, the portion of a fault tree depicted in Fig. 27 can be read as follows:

Event 1 can only be caused by the co-existence of the four events under Gate A. That is, it takes the occurrence of A1 and A2 and A3 and A4 to cause Event 1. This means that the system offers students alternate ways of reaching a desired goal, i.e., attainment of special skills. Event A2 can be caused by either B1 or B2 or B3--any one of these can cause the failure above the gate. Event A3 can be caused by C2 given the condition of C1. Event A4 can be caused by any one of the events under Gate D--either D1 or D2 or D3. The triangles under the boxes labeled B1, B2, B3 and C2 indicate that the causes for those events are diagrammed on another page (transfer symbols).

It can be seen that FTA provides for the analysis of possible weak points in a system by means of logic relationships. Analysis of many educational systems (programs) has shown that most of them have built in design weaknesses--the lack of provision for alternate paths to success for students is a striking example.

When the tree is finished, mathematical formulas based on the probability of occurrence of individual events are applied to determine the critical paths leading to the top undesired event. On large trees, the data are fed into a computer for simulation and quantification.

The importance of finding the critical path through FTA is that it provides a clear indication to the educational manager as to the weakest links in the system, and thus gives information for decisions regarding the best allocation of resources. By identifying the most probable *failure* modes, the manager can then redesign all or part of the system for *success*. Critical paths in FTA perform different functions from those in PERT and CPM, but the principle of charting a clear path through complex networks of activities and events is the same.

A fault tree superficially has some of the same characteristics as a decision tree, but the use of logic gates in FTA to show interrelationships results in a different kind of analysis. FTA can be used to evaluate systems already in operation or only on the drawing board. It is valuable in the planning stages of a new program as both a design tool and to evaluate the probable effectiveness of the system once it is in operation.

Fault Tree Analysis cannot be performed effectively until after the graphic portrayal of the system as it is supposed to operate has been completed. This may be done in the form of a flow chart which shows the movement of people and events in time through the system, and should include decision points showing possible alternative paths that people or events can take through the system. This is variously called an operations analysis, an operational map, or operational flow chart--as distinct from a functional flow block diagram. The Fault Tree Analysis then works backward through the system, tracing the events, their interrelationships, and concomitant conditions which could result in failure.

The concept of Fault Tree Analysis was originally developed by the Bell Telephone Laboratories to perform a safety evaluation of the Minuteman launch control system. Engineers discovered that the method used to describe the flow of "correct" logic in data processing equipment could also be used for analyzing "false" logic resulting from component failures. The format was also well suited to the application of probability theory in order to define numerically the critical fault modes.

Further analytical and mathematical development of Fault Tree Analysis has occurred principally in the Boeing Company. Recently the use of Fault Tree Analysis was mandated by the Department of Defense for use as a part of systems safety engineering on all aerospace projects. The use of this technique has also spread to the consideration of problems such as highway safety and hospital management.

The first full scale application of FTA to educational planning and evaluation was done in 1967-68 by Witkin and Stephens under the auspices of the Alameda County PACE Center. They were interested in discovering a predictive tool which would act as an "early warning" signal to educators regarding critical needs to which they should direct their attention. The technical report published in October 1968 (35) includes a chapter which gives the principles of fault tree construction and a prototype fault tree related to failure of employment of high school graduates. The qualitative analysis of the tree, which has over 700 events in its eight branches, has provided a model for planning new programs in the area of vocational education and career guidance.

2.4 Decision Trees and Fault Tree Analysis

Current research by Witkin and Stephens is directed toward the validation of this analytical method for educational planning and evaluation through the application to real systems, and the modification of quantification techniques derived from aerospace engineering for use in education. New formulas for determining critical paths, using empirically-derived probabilities and Bayesian statistics, have been developed by Stephens (34), and preliminary applications to problems of vocational education indicate considerable promise for FTA.

In the present state-of-the-art, it appears that FTA is a useful tool for educational planning and management in the following ways:

1. It forces the asking of those questions which identify the things that retard attainment of objectives or, worse, result in absolute failure to reach them.
2. The completed tree makes it possible for expert judgment to be brought to bear on one portion of a problem at a time. Perhaps most important, it shows the *interrelationship of all elements in the program in a systematic way*, providing information to teachers, principals, superintendents or school boards, of a type and in a form which can provide a rational basis for decision-making.
3. Since a good tree has predictive value, it permits redesign of new programs or the building in of safeguards before the program is put into operation.
4. It can also provide continuing evaluation of a program in operation, thus signaling the need for correction to prevent failure.
5. Its greatest value lies in its use as a planning and design technique. When properly implemented, it can assist instructional planners and educational researchers to discover the most probable weaknesses in a plan, and thus provide data for decisions regarding the allocation of resources for the improvement of the system. Most evaluations of new programs are concerned mainly with

"products" of a change. Fault Tree Analysis also provides for "process" evaluation, and is thus particularly applicable to field studies.

6. It enables the educational manager to analyze opinions, value judgments, and philosophical statements into objective, prioritized statements of events, thus providing a more logical basis for decision making. (35)

Finally, experience has shown that even when a full scale Fault Tree Analysis is not made, the analytical process involved, when used in conjunction with the operational mapping of a system, can be of immense help to the person(s) concerned with planning and evaluation. Although simulation is desirable to determine critical paths, it has been found that qualitative analysis through inspection of the inputs to the tree can provide important insights.

2.5 Relationship of MIS to PPBS, PERT, Decision Trees, and Fault Tree Analysis

It is apparent that the organization and retrieval of information is at the heart of all systems approaches to educational administration, planning, and evaluation. As stated before, the management information system constitutes the core of PPBS. As a management tool, network procedures such as PERT and CPM rely heavily upon the storage and retrieval of pertinent information, regardless of whether computers are used in the process or not. Decision trees use information on present and (probable) future states to predict the results of alternate solutions to problems.

Likewise, Fault Tree Analysis is in itself a management information system, as well as being a network tool. In the case of FTA, data are gathered regarding the probability of occurrence of the "fault" events, so that a critical path may be established. If Fault Tree Analysis is conducted properly within the framework of a system approach, it gives the administrator information on those essential places within his system which should be monitored or redesigned. Once the analysis is accomplished, and system changes are made as needed, FTA does not constitute a management tool in the same sense as PERT; but the findings can and should be referred to frequently in order to assess the system as to whether the requisite changes have taken place.

FTA can also serve as a kind of "early warning signal" regarding the points at which the system might break down later if it is not changed. For example, the combination of operations analysis and FTA might show that a particular program is working to capacity now in terms of the kinds of supportive services it has or the number of students it can accommodate; but that if more students enter the program, it will become seriously overloaded and will break down. Thus FTA can provide an administrator or program director with data regarding the types of information that will be most useful to gather, and indicate possible courses of action to take on the basis of the data.

Management information systems, therefore, are essential to the application of a system approach to education. The definition of the system and the use of network management tools assures that the kinds of information gathered will be those most needed for administrative decisions and that there will be appropriate analysis and interpretation of the data in order to lead to those decisions. It is obvious that this approach is a far cry from the mere collection of various kinds of data for reporting purposes or the collation of statistics. All too often, unrelated data from school systems are fed into computers, only to result in massive numbers of information documents and print-outs lying on the shelves, not available or inappropriate for feedback to decision makers. It is this kind of error that the installation of organized management information systems is designed to correct.

3.0 COMPONENTS OF MIS

The first step in planning any MIS, as in system analysis and PPBS, is for the users to state clearly and precisely their goals and objectives. The components must be related in their functions to these goals.

Bolton states that there are three components of an information system--the stages of the decision process, the functions to be performed, and the sources of information. His three dimensional model (Fig. 29) shows the interaction among four stages (analysis, choice, implementation, and evaluation), four functions (acquisition, storage, retrieval, and analysis and interpretation), and two sources (external and internal to the organization). The model is useful for determining responsibility for information in the various cells--e.g., the principal, the research division, business manager, or assistant superintendent. If there is poor information, much uncertainty is present in the decision process. (2, p. 10)

Fig. 29

Bolton states:

> An information system for decision making in an educational organization should contain both formal and informal procedures. The formal tends to systematize data collection and clarify relationships of potentially conflicting goals. Information available via informal procedures may not be accessible by formal procedures. The formal procedures may cost more than the informal, but they have greater potential for producing higher quality, acceptable decisions. (2, p. 9)

3.0 Components of MIS

Rosove lists the following elements or subsystems of an information processing system; (27, p. 106)

Data
Personnel
Display
Equipment (that is, input, output, transmission, logical
    and arithmetic processing, and storage)
Learning
Retrieval
Programming

Following is an explanation of the elements, based on Rosove:

(1) Data element - A system user's need for information can be satisfied only by acquiring and transforming data. Providing the information is the essential function of an information system. [Emphasis added] After the acquisition and transformation of data by the system, the data are further transformed into information by the user when he exercises judgment and formulates actions that will help to accomplish his objectives. Data do not constitute a management information system until there is some provision for transforming the data in such a way that the user can formulate action based upon it. (29, p. 106)

(2) Personnel element - This usually refers to the attributes of the people who will operate a particular system. In an information system, people not only use the outputs of the system but also are components of the system. It is helpful to distinguish between these two cases. In the one situation people monitor and use the information produced by the system but do not serve as an information input source (except very indirectly through policy and procedures) for the rest of the internal system. In the other

situation, people not only monitor and use the information but do inject instructions into the system in the form of computer requests; these are instructions to which the system must respond. In information systems that require complex man-machine interactions, the interactions are more flexibly structured than in the situation where men are passive receivers of data from noncomputing machines that have a relatively limited repertoire of response. (29, pp. 108-9)

Under the personnel element, one must take into account the distribution of responsibility and the various "seats" of decision making prerogatives.

> This means the specification of the location, skill, and number of people or groups of people who have the responsibility and authority for taking all of the various types of actions available to the system users. The authority, the responsibility, and the knowledge should reside in the same place.
>
> The human actions and the methods for accomplishing them are an inherent part of any information system. These human actions are: monitor, compare, assess, predict, decide, command, inform, request and comply. The particular applications of these actions, plus the ways in which they are accomplished, form the operating procedures. (29, pp. 109-110)

(3) Display element - This refers to any presentation of data to people by means of equipment. Displays form the major interface between the user and his system.

(4) Equipment element

> The equipment element is composed of engineered units, the physical devices through which all data flow. When we are dealing with hardware design, it is convenient to regard the element as two major units, the computer unit and the computer communication unit. The digital computer is perhaps the more

> complex and in a very real sense is a complete system itself, one which inputs, stores, processes, outputs and transmits data. An information system customarily would employ a general purpose computer which can do almost any kind of logical and arithmetic processing typical of the class. The communication unit includes all the hardware for sensing, inputting, outputting, and actually transmitting data through the system as a whole. (29, p. 110)

Archibald states:

> Most contemporary systems involve manual data collection and input, machine processing, tabular and graphic output production, and human analysis and interpretation. (1, p. 372)

(5) Learning element

The learning element is included in order to point out the need to design into the system provisions for adaptation and response to experience and new user requirements. This learning element could consist of any one or all three parts: operational evaluation in recording, training, and system adaptation. (29, p. 116)

(6) Retrieval element

The retrieval element is a critical one in an information system. It is responsible for organizing and obtaining access to sets of data specified earlier in the design phases from large and complex files contained in computer storage. Although it is not clear what all the attributes of a retrieval element are, at least these would have to be specified:

--a syntax for man-machine communication;
--an indexing scheme so that a human operator can readily perceive the structure and contents of the system data or datum base;
--all of the attributes of a display element and of the input and output parts of the hardware element.
(29, p. 117)

> (7) Programming element
>
> The programming element is a complex one and there are various types of computer programs to be considered in system design. Some of them are data manipulation programs, (that is, aggregating reports of events); input and output programs; utility programs (for example, preparing tapes, punching cards); executive programs (that is, programs which control other programs); and finally, retrieval programs as distinct from fixed output programs. (29, p.117)

Linking all of these components together is the flow of information throughout the system, both oral and written. Educational systems, much like military systems, often have a chain of command in which the flow of command is from superior to subordinate and the flow of information from subordinate to superior. One result of the traditional transmission of information along the vertical chain of command is that lateral communication is not developed to a comparable degree. In a typical large scale organization, personnel of equal rank, for example department heads, are under no formal obligation to communicate with one another. This is certainly true within many schools and in school districts where departments function and report vertically to the top without knowing what other departments are doing. With the introduction of automated information systems, it is absolutely essential that there be lateral as well as vertical flow of information.

An example of both vertical and horizontal flow of information in a PPBS context is given in Fig. 13.

In summary, an MIS consists of many components--people, hardware, software, data--interacting as a system to perform specified functions related to the achievement of the educational system's objectives.

4.0 STEPS IN DEVELOPING AN MIS

4.1 General considerations

Too often in education, as well as in business, the MIS is developed or sold pre-packaged by hardware specialists without reference to the unique needs of the user. Siegel (32) makes a plea for the manager or executive to develop the model for a management information system and for the data processing people to act simply as technologists. He points out that there are many technological systems which are used to improve the capabilities of the management information system. These have consisted of such things as filing cabinets, typewriters, adding machines, bookkeeping machines, etc., and recently computers have been added to the list.

Any business system, as well as any educational system, is dynamic and not static--that is, it possesses feedback. For this reason, it is often difficult to determine which are the inputs and which the outputs. For example, a saturation of the market with a product this year may cause a reduction in the number of incoming orders next year. An analogy from education might be that a change in the birth rate may affect schools five years later. Educational systems, like business systems, are also adaptable to changes in environment. Siegel states, "It is simple minded to think that to plan all one needs is to set objectives and then determine what resources are necessary to achieve them." (32, p. 59)

The MIS is a reflection of how the administrator or manager sees the educational system, whether it be a single school, district, county office, or state department. The manager makes the decisions; the manager must make his own models. Examples of models are financial statements, schedules, accounting systems, and instructional programs.

Fig. 30

If the manager is his own modeler, then the operations research men, management science people, mathematicians, system analysts and programmers are all technologists with specific areas of expertise who can aid the manager by supplying specific techniques to add rigour to the modeling.

As Siegel states:

> The executive plans his MIS; the EDP technologist designs tools to aid him, which is counter to the way things have been going. When computers first arrived, data processing experts convinced their managers that here lies a new tool that managers must understand in order to improve their decision making. The managers fell for the line and have been so busy trying to fathom the mysteries of data processing that they have neglected their real task: management. (32, p. 60)

Both the manager, that is, the school administrator, and the EDP technologist should keep to their respective specialties. The manager should plan his own MIS and the EDP technologist should design the necessary tools and data base. Siegel has a model for MIS planning within an educational system.

Fig. 31

4.1 General considerations

The following discussion of the phases of development is based on Rosove's model: (29)

Fig. 32

4.2 *Phase I*. *Requirements*. This determines *why* the system is needed, identifies the system users, and defines the information needs. Rosove states:

> An information system is developed by translating a user's goals and objectives into a design for facilities, computers, computer programs, personnel, communications, and equipment. The goals and objectives must be transformed into a set of operational requirements before design work can begin. (29, p. 67)

The following questions should be asked:

--Why is the system needed?
--What kinds of information will be needed?
--What is its purpose or purposes?
--What is it expected to do?
--What problems is it supposed to solve?
--What kinds of decisions will be made on the basis of the information?
--Who will be using the system?
--What are their objectives?
--What preliminary qualitative and quantitative requirements for a system can be inferred from the users' objectives?
--What are the possible sources of the information needed?
--What is the best way of gathering, storing, and retrieving the information? Are computers necessary now? Will they be later?
--What kinds of outputs will be needed? In what form?
--What are the time requirements for getting the information?
--Will the users be able to interpret the information correctly when it arrives?
--What alternative MIS designs are available for *this system's* needs? What are the values of each in relation to cost?
--If "canned" programs are available, will they fit in with this system's requirements?

As an outcome of this first phase, there should be a comprehensive statement of requirements which tells *what* the MIS is supposed to do, in both qualitative and quantitative terms, but not *how* it is to do it.

4.2 Phase I. Requirements

4.2.1 Analysis of data in the present system

An important part of Phase I is the analysis of the present system. In most school systems there are information processing elements of a manual, or semi-automatic nature, which were not designed or created as a system. Typically the various components which provide for the flow of information are developed independently and at different times to meet a number of uncoordinated needs. It is often necessary to replace these components with a system which is designed as a "totality" to meet all the information needs of administration. In a system development effort, the important thing is the viewpoint, in which information processing is conceived as one element of an integrated system--the integration of the school system and the information network.

It should be noted that the object of information system planning is not automatically the creation of a "total system" but recognition by top school administrators, as well as other users, of the need for planners to study the totality of information system requirements throughout the enterprise.

Fig. 33

Some of the types of data which may already be available in various forms are the following: (26, pp. 5-7)

A. CERTIFICATED AND CLASSIFIED PERSONNEL FILES

1. Identification and personal data
2. Educational data
3. Skills data
4. Employment history
5. Salary history

6. Assignment data
7. Personnel function activity
8. Past employee data
9. Salary and benefits data
10. In-service training data
11. Test data
12. Evaluations

B. OPERATIONS DATA FILES

1. Purchasing
2. Supplies and inventories
3. Maintenance records
4. Cafeteria operations
5. Library and publications
6. Transportation

C. FINANCIAL DATA FILES

1. Budgets/appropriations
2. Payroll
3. Accounts payable
4. General accounting (including encumbrances)

D. PROGRAM DATA FILES

1. Program identification
    a. Course identification
    b. Status (experimental, pilot, standard)
    c. Effective dates
2. Financial
    a. Budget
    b. Expenditures
3. Program Conduct
    a. Teacher(s)
    b. Students
    c. Materials
    d. School(s)
4. Program Evaluation

E. PUPIL-PERSONNEL DATA FILES

1. Identification and personal data
2. School data (including grades and test scores)
3. Family and home data
4. Educational and mental development
5. Emotional development and attitudes

6. Social development and attitudes
7. Health and physical development
8. School experience and plans
9. Special activities and interests
10. Current educational activities
11. Administrative data
12. Attendance

F. COMMUNITY CHARACTERISTICS FILES

1. Identification data
    a. Political
    b. Geographic
    c. Postal
    d. Administrative
    e. Zoning
    f. Streets
2. Facilities and services
    a. Recreational
    b. Cultural
    c. Law enforcement
    d. Fire Protection
    e. Health/welfare facilities
    f. Transportation
3. Socioeconomic characteristics
    a. Property values
    b. Dwelling types
    c. Police information
    d. Neighborhood characteristics
    e. Occupational groups
    f. Welfare data

Each of these files could be examined to answer the following questions: How important is this information? What is its source? What format is used? How available is the information? What decisions can I make on the basis of this information? What are the interrelationships among the various kinds of data here? Do these files give me information I need for future planning, to tell me how well each program is meeting its objectives? If not, what other kinds of information do I need?

4.2 Phase I. Requirements.

In examining existing data files, the planner should decide which one or more of the purposes of MIS (discussed below in Section 5.0) the data are useful for. These can then be assigned a priority for development.

4.2.2 Analysis of processing elements in the present system

After examining the data required, the planner should analyze the existing information system (not just the data available) to see which of the following situations apply:

1. There are no existing relevant information processing elements of any kind, or
2. There are relevant but unintegrated information processing elements, or
3. There is an obsolete or inadequate information system.

An example of (2) might be the case in which a computer facility is available for payroll and accounting, or where report cards are made out from optical scan cards. An example of (3) might be that a school district or county office has bought a "canned" system or has installed a computer without analyzing its capabilities in the light of the system's requirements. An MIS consists of much more than the hardware used for processing the data. If there is already an operating information system, then the manager has to decide (1) whether the current system has unidentified problems, or (2) whether he actually knows what the current system problems are.

In the first case, the manager or administrator may be aware that he is running into difficulty but he doesn't understand what the problems are.

He should then call in someone from outside to analyze the operations and tell him what ought to be done to accomplish his goal. Administrators should have some technical capability to do a system analysis or alternatively should see the need for an outside consultant to do this. When an administrator calls in an outside consultant or developer, he should appreciate the extent to which he as a manager must work in close cooperation with the consultant in all phases of the development effort.

In the second case, when the current system problems are identified by the user, it means that he has conducted a preliminary analysis and simply asks a consultant or developer to provide the solutions. Although this approach has some advantages in that the manager understands the need for change in his operation and has some understanding of what these changes might be, he may not have correctly or completely identified the difficulties and thus tends to accept traditional ways of operating without question. The ideal thing is to have the consultant or developer study the user's information system as a totality rather than being arbitrarily confined to the problems specified.

Rosove points out:

> An information system, for maximum effectiveness per dollar cost, should be an operational and functional totality. Operational problems cannot be treated as isolated elements, unrelated to the total information flow. It may well be that a study of the total operation of the enterprise will reveal that there is an underlying cause of several apparently isolated operational problems. If the user's statement of the problem is accepted as given, and only solutions for these difficulties are sought, such underlying causes may never be isolated and identified. (29, p. 74)

He continues;

> An operational solution may be defined as a way of employing given resources to accomplish a set of objectives under a given set of conditions. . .The requirements for a given information system may be either derived from an analysis of the user's mission or objectives or deduced from existing operational solutions or new operational solutions that the user may invoke during the lifetime of the system. . . The most effective system capability cannot be created unless the developer examines not just the problems defined for him by the user, but also the entire operation of the enterprise and all the requirements for information as deduced from the user's needs and objectives. (29, pp. 74-75)

Jaffe notes:

> Statements about the general objectives of the user should be phrased so that the designer can infer the kinds of tasks the system must perform in order to accomplish these objectives. Sometimes, of course, the tasks to be performed are defined as the objectives. This should not be permitted. Objectives are goals, and tasks are ways of reaching goals. Another way of expressing the same idea is to say that objectives are specified by asking 'why?' and tasks by asking 'how?' Information systems can have only three general objectives:
>
> --To communicate
> --To process data
> --To control environment and resources. (29, p. 119)

If user objectives become too specific, such as specifying the kind of adding machine that should be used, they become a direct part of the system task requirements. They are then constraints which limit the design. Other constraints may be the user's resources in terms of time, money, adaptability.

4.2.3 Specification of system task requirements

The last step in Phase I is to specify the system task requirements. The following questions should be asked:

--What are the tasks?
--Why is each task performed? (Means-end; higher-order means--higher-order end.)

4.2 Phase I. Requirements

- --Where is each task performed, and where are the resources which are manipulated?
- --By whom or what is each task performed?
- --With what is each task performed? (Data, computational routines, formulas, etc.)
- --When is each task performed, that is, under what conditions, at what times? In short, what happens to initiate, continue, terminate, or reiterate the task performance?
- --How is each task performed? (This is a fitting together of the previous material.) (29, p. 120)

An information system will usually be required to accomplish one or more of the following general categories of tasks in order to accomplish the user's objectives:

- --Planning to obtain resources
- --Planning use of resources
- --Assessing the environment
- --Assessing one's own resources
- --Manipulating or moving one's own resources
- --Assessing system status
- --Changing system status
- --Interfacing with other systems
- --Surviving (protecting the system's capability to accomplish its mission). (29, p. 121)

4.3 Phase II. Design

Fig. 34

Fig. 34 shows a schematic representation of the design process with a partial time sequencing. The process starts at the upper right hand of the figure with the user's conception of the system and proceeds to the bottom of the figure where the processes represented are the end of some describable phase of the design effort. In rough order, the steps proceed from a feasibility study, to format of the design document, to identifying system elements, through specifying the system element requirements. At this stage also, information from user requirements and system task requirements are fed in.

All of this information is integrated into the writing of the document which designs the system and evaluates it, and information from these processes are fed back to the management. Two feedback loops (dotted lines) are shown, but there are probably many more formal and informal ones. All of this information leads to recommendations on design continuation and the process continues as a cyclical one.

Figures 35 and 36 show two possible designs for an MIS.

Figs.35 & 36

Another concept in this phase relates to personnel and organizational design. This is concerned with (1) the characteristics of the personnel manning the positions in the system, (2) the characteristics of the positions, (3) the arrangement of the positions to perform functionally related units in groups, and (4) the arrangement of units in groups so as to meet more effectively the operational objectives of the system. (29, p. 168)

If a school system decides to install automated information processing equipment, its introduction may not only eliminate or alter existing jobs, but also create new ones. New tasks, duties, and responsibilities may be added to existing jobs, while old tasks, duties, and responsibilities may be abolished. Rosove points out:

4.3 Phase II. Design

> The use of a computer to carry out routine types of decision making may alter the existing chain of command. The flow of information into and out of the computer and its auxiliary devices may change the flow of information both laterally and vertically throughout the old organization.
>
> With respect to the personnel of the new system, the developer must resolve these types of questions:
>
> 1. What new tasks must be performed to carry out new system functions?
> 2. What behavioral problems are associated with the conduct of the new tasks?
> 3. What kinds of skills, intelligence, and knowledge must the system personnel possess if they are to perform the tasks efficiently?
> 4. What kinds of people possess the required skills, intelligence, and knowledge, or could acquire them with the least effort if necessary?
> 5. What is the impact of a computer-based technology upon the job classification system in use in the enterprise?
> 6. To what extent will the content of existing jobs be changed by the introduction of a new, computer-based information system?
> 7. What will be the effect of the new system on existing career ladders? (29, pp. 169-170)

The foregoing questions should be of concern to anyone considering the design of a new information system. All too often, questions of design are limited to the hardware and software, and not to the organizational requirements and the personnel to be affected. It is obvious that not only the personnel who provide input to the system and manage the data processing per se will be affected by the changes, but also people who at first glance may seem only remotely connected with the system. Their jobs and methods of working may be affected in ways that were completely unanticipated and there may be considerable strain in the organization as a result.

4.4 Phase III. Production

This phase is concerned with engineering aspects that are outside the scope of this paper.

4.5 Phase IV. Installation

The installation phase is of critical importance in the development of an information system. Three things need to be done:

1. Test and verification of the system design concepts in the operational environment.
2. Psychological acceptance of the system by the users.
3. The development of an operational capability.

A factor which contributes more than any other to the inefficient use of an automated information system is that the user assumes that when equipment is installed, all of the problems will be automatically solved. Rosove points out:

> When the power is turned on, the new information system will not operate as smoothly and efficiently as the one it is replacing. The computer-based system should not be expected to perform at maximum proficiency on the day when the last piece of hardware on the last computer program is checked out and installed, and the human beings who are a part of this system are assigned to their positions. (29, p. 203)

One possible reason why the transition from the old system to a new one might not be smooth is that no agent is provided to link the people, the machines, and the computer programs within the institutional environment. It is imperative that the people who will interact with or use the system be provided with links which serve to orient and educate them before the system is installed and operated, and to guide them when it is operational.

4.5 Phase IV. Installation

Recently it was noted that state government in California has 49 separate and independent computer operations costing more than $60 million this year (1969-70). It was reported that some of the sophisticated and expensive data processing machines are not used nearly to their capacity, and that one is being used only 17 percent of the time. (30)

As a result of a detailed study by a private consulting firm of the State Department of Education's computer operation, the state legislative analyst has proposed that all departments, except the state colleges and the University of California, be stripped of their computers. The proposal was that the state would establish a centralized data processing operation that would make services available to departments, with departments buying computer time from the center.

Various solutions have been attempted, including writing so-called "control language" into the budget and creating an office of management services. None of these has been satisfactory.

It is apparent that there have been serious problems of design requirements, installation, and operation in data processing at the state department level. It is possible that the operation was never conceived of as an information system in the real sense, and that many of the problems could have been prevented if adequate planning had been done within a system design. Although the legislative analyst thinks that from a cost accounting standpoint the entire operation ought to be centralized, that may or may not be the real problem. Allegations have been made that each of the department heads wanted bigger and better computers, and that they conceived of their needs independently from the needs of the entire system of which they were a part.

On a lesser scale, this kind of problem can occur at the regional, county, or school district level. It points up the need for carefully following the steps that are outlined in this section in order to produce a management information system in which the hardware, software, personnel, and management structure are integrated to perform the functions for which they were designed.

Information systems must be custom made to fit the user. It is irrelevant to use hardware models to design information systems. Systems may vary considerably in the degree to which they utilize well-established computer programming concepts in association with off-the-shelf computer equipment. More time and money should be devoted to the conceptual phase of information systems and the creation of a test facility than is now the case. Unfortunately, military models, which can be built once and then duplicated for similar operations without distortion, have sometimes been used for business and educational systems. In non-military information systems, however, we are working with one-of-a-kind systems rather than a prototype which can be unchanged for other smaller systems. This poses many special problems for training which do not exist for one-of-a-kind systems. Training must be conducted in this instance without interfering with ongoing operations.

4.5 Phase IV. Installation

> An information system has the capacity to adapt itself to changing situations and the capacity to learn from experience. . .Modifications to the system are made through an on-going dialogue between system users and designers. As they apply the system and gain experience with it, the users recommend to the designers improvement in procedures, computer programs, displays, etc. (29, p. 41)

4.6 Phase V. Operations

An automated information system requires ongoing maintenance if it is to be kept at maximum performance, but there is a question as to whether in-house staff can maintain an information system to an acceptable performance level. The skills of computer programmers, system designers, and analysts cannot be acquired overnight. If there is no in-house capability for maintenance, the user should continue to rely upon the developer. It is possible that the stories one hears about the inefficiency of computers to deliver information at the right time, in the right form, etc. are due to the fact that the organization or institution is depending on an in-house capability which it does not have.

Even if the MIS is not automated, constant checks must be made to be sure that the channels of communication are kept open, and that procedures continue to be relevant to the information needs of the users.

4.7 Summary. Designing and implementing an MIS is a logical process employing the tools of system analysis. Another way of tying together system analysis and management information system development is to look at the procedure as embodying the following steps:

C8

4.7 Summary

1. Define the problem in as much detail as possible.
2. Determine the objectives of the administration of the educational system which will be using the MIS.
3. Establish the boundaries of the system under consideration.
4. Study the relationship of the system to its environment.
5. Study the interaction of the system with other associated systems, both existing and contemplated. This is known as system interface.
6. Develop a basic concept of the new system.
7. Define, in a preliminary sense, the new system's functions and subsystems.
8. Conduct constraints analyses and a feasibility study.
9. Determine the type of development strategy best suited to the particular development activity. (29, p. 79)

One more word should be said about the system approach in general and its application to MIS. Since a system consists of interrelated parts, whatever affects one part of the system will affect all others. Although this appears like a simple concept, the implications are widely ignored in educational systems as elsewhere. It is impossible to add or subtract anything from one part of an educational system--whether it be administration, facilities, scheduling, staff utilization, curriculum, or collecting and processing of information--without affecting some or all of the rest of the system. Innovations and changes cause stresses and reallocation of time and resources which are often unplanned for. The whole essence of the system approach is to take a look at the enterprise as a system, and anticipate what the effect of any changes might be.

4.7 Summary

This is not a one-time procedure. Feedback from various parts of the system must go to other parts and above all to management in order to make constant corrections as needed. Management information systems, like other subsystems, are dynamic, not static, and need constant monitoring for maximum effectiveness. Regardless of whether the system is a relatively simple one, manually operated, or whether it involves expensive and sophisticated computer equipment, the same principles occur and cannot be overstressed.

5.0 EXAMPLES OF MIS IN EDUCATION

5.1 General administration and management

Management information systems which have as their purpose to provide bases for decision making should be distinguished from information retrieval systems used primarily for research or for planning new instructional programs, and from the use of computers to teach basic skills to children (CAI). These other types of information systems or uses of computer technology, which could be incorporated into the larger management network system, will be discussed in later sections.

From the management point of view, a useful way of looking at the informational needs of an MIS is in terms of the subsystems of a school district or county office. These categories are suggested ones compatible with PPBS data areas: [Adapted from Price (26, pp. 10-11)]

1. Pupils

   a. Grade reporting
   b. Attendance reporting
   c. Testing

      1) Local
      2) Standardized

   d. Scheduling
   e. Enrollment projections
   f. Census
   g. Follow-up studies

2. Personnel

   a. Skills inventory
   b. Certification
   c. Health

3. Program, curriculum, instruction
    a. Library listings
    b. Film bookings
    c. Resource center utilization
    d. Developing curricular programs
    e. Computer Assisted Instruction (CAI--student interacts with a computer)
    f. Computer Managed Instruction (computer keeps track of student contract system)
    g. Scheduling as a curricular tool
        1) Flexible scheduling
        2) Daily demand
4. Facilities
    a. Utilization
    b. Maintenance
    c. Site inventory
    d. Simulation--five year projections
5. Finance
    a. Payroll
    b. Inventory
    c. Budget accounting
    d. Accounts payable
    e. Financial projections
    f. Food service
    g. Transportation
6. Community demographic data
    a. Population trends
    b. Socio-economic trends
    c. Geography
    d. History

Another way of conceptualizing the framework for an MIS in schools is by way of Miller's three-dimensional model. One dimension is related to educational goals, which have both input and output characteristics; a second dimension is related to change characteristics in the personality, individual growth and development, and the environment; and the third dimension consists of school programs from early childhood and elementary education through adult and community service.

Fig. 37

An MIS can be constructed to provide information for any of the 252 cells in the model to show variables related to the present state-of-the-art, as well as probable future states. In this model information would be used to provide data over time for decisions relative to issues, alternatives, consequences, problems, goals and objectives, plans and strategies, and procedures.

Fig. 38

This is a comprehensive model which synthesizes concepts from the behavioral sciences, PPBS, curriculum development, and school management into an integrated whole.

The California Educational Information System (CEIS) has been developed as a statewide system to assist districts in meeting their information needs. As reported in the Bulletin of the California Association of School Administrators (September 26, 1969), the purpose is:

> To make complete, current, and reliable information relating to education available to the legislature and all public agencies in California at maximum efficiency and economy through statewide systems in the development and application of information systems and electronic data processing techniques.

5.1 General administration and management

The objectives of CEIS have been stated as follows:

1. Permit all educational institutions and organizations access to a statewide coordinated system for automated processing of information.
2. Facilitate the cooperative utilization of computer installations for instruction and administration.
3. Establish an organizational structure that will support a communication network to link the local institution, the regional center and the State Department of Education.
4. Utilize a common data base and an integrated system.
5. Facilitate the development of pilot projects and exemplary programs that can be shared by all institutions.
6. Promote wide participation in the development and evaluation of the information system.
7. Provide education agencies with automated techniques for use in the evaluation of the educational process.
8. Promote compatibility between all education EDP systems and other interfacing systems. (26, p. 21)

According to Kiesel, one reason for the development of CEIS was that the rapid increase of computer usage in education at the school district level caused concern within the educational community. The use of electronic computers for data processing has been increasing and the use of computers for computer assisted instruction (CAI) has been receiving a lot of attention. There was a feeling that there might be inefficiencies due to duplication of effort, poor cooperation between agencies, and poor system analysis and programming practices. "One obvious solution to this problem is the development of a basic computer program package that could meet the basic data processing requirements of all California's school districts. This one program could then promote the compatibility necessary among school districts." (21, p. 59)

CEIS is operated by the State Department of Education through the Bureau of Systems and Data Processing. There are two subsystems available at present--the business subsystem, and the pupil personnel subsystem. In the business subsystem the main emphasis was placed on the CEIS concept of developing an information system for local district use in pursuit of its basic processing needs and only as by-products to generate information required by county, state, and federal agencies.

The design of the business subsystem includes five applications relating to (1) system control, (2) stores inventory, (3) accounts payable, (4) personnel payroll, and (5) financial reporting. A CEIS progress report states: "While the total system design includes the capability for each application (excluding System Control) to operate on a 'stand alone' basis, the basic strength of the design is in the interrelationship of one application to the other, thereby complementing the overall process." (5, p. 2)

The pupil-personnel subsystem serves over 500,000 secondary and elementary principals in California. It is composed of seven application areas: (1) student scheduling, (2) attendance accounting, (3) mark reporting, (4) California guidance testing reporting, (5) guidance reporting, (6) master file maintenance, and (7) administrative and educational planning report series. The administrative and educational planning application was recently developed to provide management information reporting from data stored in the student history file. There are three series of reports in this application: honor lists, achievement deficiency reports, and comparative analysis reports. (6, pp. 1-2)

5.1 General administration and management

A task force was formed to provide the framework through which the various educational entities could work cooperatively toward meeting their management information and data processing needs at minimal cost. The following organizations have representatives on the task force:

State Department of Education
California Educational Data Processing Association
California Teachers Association
California Association of School Business Officials
California School Boards Association
Regional Data Processing Centers
University of California Advisory Commission on School District Budgeting and Accounting
Los Angeles City School System

The first priority was to develop a master plan for CEIS which establishes a position and guidelines for implementation and utilization. Subcommittees were formed to do the following tasks: data base element, computer program documentation, EDP evaluation, EDP information dissemination, confidentiality, and program budgeting and accounting. (21, p. 61)

There is considerable doubt among many educators as to whether the CEIS is doing as good a job as is needed and whether school districts should buy these packaged systems. In a sense, the buying of pre-packaged systems violates all of the tenets of a good MIS. It is not certain whether districts use these subsystems for reporting only, or for real decision making, and more study would have to be done to find out how well the subsystems are working in relation to a total MIS concept.*

Antedating the CEIS was the setting up of ten regional Educational Data Processing (EDP) Centers in California, most of them funded under ESEA Title III.

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*For further information on CEIS, contact Robert L. Howe, Coordinator, Bureau of Systems and Data Processing, Dept. of Education, 721 Capitol Mall, Sacramento, CA 95814.

5.1 General administration and management

The original task was to develop an integrated system of pupil personnel services that could be implemented by the use of Regional Center computers. A comprehensive analysis of the Centers which was made by the Arthur D. Little Company in 1968 recommended that CEIS make use of the regional EDP centers as a means of collecting and summarizing data. The Centers are located in Ventura, Sacramento, Fresno, Kern, San Mateo, Contra Costa, Sonoma, San Francisco, Santa Clara, Riverside, San Diego, and Los Angeles Counties. While these Centers do not in themselves constitute management information systems, they have the capability to provide counties, districts, or the CEIS with the computer services necessary to support certain MIS efforts. (23)

Another example of an operational MIS is project O.T.I.S.--the Oregon Total Information System.* The purpose of O.T.I.S. is to develop a statewide educational data processing system that will improve the educational opportunities for Oregon students and teachers. There are two project goals: "First, to build and maintain a service organization that can provide Oregon schools with the hardware and technical staff necessary to meet their computer requirements, and second, to jointly develop with each user a plan that can assure that institution of an efficient and economical utilization of the O.T.I.S. hardware and staff." (27)

The O.T.I.S. system is different from the California system in several ways. It appears to be a cooperative venture between the state and local districts. The system was designed to be responsive to the needs and desires of the local school districts and to be controlled and supported by them.

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*For information, write Robert Dusenberry, Director, 354 East 40th, Eugene, Oregon 97405.

5.1 General administration and management

Project O.T.I.S. has its headquarters in Eugene, Oregon. The main computer system, consisting of an IBM 360, Model 50 computer, is connected to the participating schools by a network of teleprocessing terminals. Through this network the schools have immediate access to the information in the Central Data Bank. In 1969/70 the program serviced 233 participants, including schools, school districts, and intermediate offices.

In order to make the system responsive to user demands, and to insure flexible utilization of the stored data, O.T.I.S. developed the General Education Management System (GEMS). There are five integrated data files--for students, staff, curriculum, property, and finances. "The flexibility of GEMS allows each user to define and maintain only the data storage and processing he requires, and to change these individual definitions as his needs for information change." (27)

The generalized O.T.I.S. concept provides for changes in format and content of any reports, as well as design of new reports, provided the interest of the users is sufficiently expressed to effect the modifications.

Also related to O.T.I.S. is the Library Experimental Automated Demonstration System (LEADS). This is an automated, integrated library system for acquiring, cataloging, and processing all library materials, both book and non-book items. In the pilot year, there were 27 participating libraries involved in implementation and testing. Any public or private school library from the elementary to college level can participate, or any instructional media center, any public library, or any library or media system in or outside of the state boundaries of Oregon.

5.2 Curriculum and instruction

Information from the instructional programs of a school district is essential not only for reporting purposes but for decisions regarding curricular and instructional changes and innovations necessary to meet student needs.

Fig. 39

As PPBS becomes operational, it will be essential for district and school building administrators, teachers, counselors, and others to have immediate access to data concerning the extent to which program and instructional objectives are being achieved. Grades and test scores alone do not tell the story. As schools move toward specifying criterion-referenced objectives for learning, with individual and class minimum acceptable levels stated, it will be necessary to have a well-defined system for tracking the information and for making relevant data available in the most useable form.

This use of information processing is different from Computer Assisted Instruction (CAI), in which the computer interacts on an individual basis with the student to teach basic skills. CAI is expensive, although ultimately costs might be reduced through time-sharing and the use of remote terminals. However, it does provide a model for individualizing instruction which points up the usefulness of immediate reinforcement in learning, when both students and teachers know at all times exactly what progress is being made and what still needs to be accomplished to achieve the objectives.

The use of computers to achieve individualization of instruction in education is not properly a part of management information systems, as such.

In one sense, however, CAI can be used as part of a decision system if it is thought of as providing not only individualized assistance to the student, but information for the teacher as to where the student is at any given time and what his next step or steps could be. When properly used, CAI could also be programmed so that data from achievement of student objectives could be fed into a central system that would actually give "management" information regarding the changes that might be made in the instructional program. (18)

(An interesting and very different use of computer technology in education is the man/machine interaction type of learning being piloted in some districts in the Bay Area by Dean Brown and others at Stanford Research Institute. The computer is used to assist in developing problem solving and other inductive skills in students.)

An important curricular application of an MIS which could be operated on either the local, county, regional, or state level, would be for the purpose of making better decisions about vocational education. Typical management questions might include the following: "How many students taking vocational courses find work in occupations they have prepared for?" "Is vocational education in California training people for the right jobs?" "What proportion of students or unemployed youth are receiving vocational education?" "Is vocational education providing a solution to the social and economic problems of minority group persons?" (22, p. 151)

School districts wishing to apply for funds under the Vocational Education Act of 1968 must now submit five-year plans, and they are finding they must maintain data banks on demographic characteristics, job market analysis, manpower needs, population trends, student characteristics, etc.--in effect, a separate MIS. Cooperative effort on a county-wide or regional basis would make this task easier. The Arthur D. Little report on Vocational Education in California strongly recommended an MIS at the state, regional, and local levels. (22)

Finally, an important function of an MIS in curriculum is in carrying out the evaluation of new projects and programs. Most new evaluation strategies, for federal projects especially, place as much emphasis on continual monitoring and control (process evaluation) as they do on the product or outcomes of the project. Various kinds of decisions need to be made throughout the stages of planning, development, installation, and implementation of new programs, including decisions to restructure or recycle if necessary.

An often overlooked problem in evaluation is to identify those persons involved in the decision process--whether they are policy makers, experts, funding sources, researchers, administrators, teachers, outside evaluators, or cooperating agencies. As Randall points out:

> It may be useless to get information to the recognized final decision maker, in that he may either have little time for considering the information, or may rely heavily on the judgment and recommendations of other people. Therefore, the evaluation system must identify the key persons involved in any strategic decision and make arrangements for getting necessary information to these people. (28, p. 7)

In innovative curriculum projects, a well thought out MIS is absolutely essential for success. On this depends the identification of types of information to be gathered, the proper timing of reporting so that decisions may be made, the relevance of the information, and the mode of interaction (whether through written communications or face-to-face interaction). "It is obvious. . .that communication and interaction with key decision makers is a cornerstone on which effective evaluation rests." (28, p. 8)

5.3 Certificated and pupil personnel

Important components of any school MIS would be data banks on school personnel--both certificated and classified--and on pupil personnel accomplishments and needs. The pupil personnel subsystem of the CEIS has already been discussed. Also discussed was the use of data from pupil achievement to improve instructional practices.

One of the management information needs that could be met more adequately by the system approach to pupil personnel would be the identifying and keeping track of students who need special attention, who are not doing well in the system but whose needs are not so evident that they are referred to special programs. If an MIS were used in conjunction with a system approach to instruction, and with evaluation procedures such as Fault Tree Analysis, it would be possible to build in alternative paths to success for students, as well as "early warning signals" to alert the teacher and others to the fact that there may be trouble ahead, and thus lead to preventive measures.

Another use for MIS is to improve the utilization of teacher competenc The objective of this would be to pinpoint sources of potential improvement that would lead to better utilization of limited funds, materials, and personnel in the teaching-learning process. Hartley cites a study by a

5.3 Certificated and pupil personnel

private concern of a junior high school of 1500 pupils which contains an interesting profile of activities and time allocations of the teachers. Factors such as the intructional activity, teaching methods, equipment, group size and skill level of pupils were classified by means of a six digit coding system. (16, p. 202)

One application of the system might be in teacher selection and assignment to particular students.

> The MIS source data for teacher placement would include training and experience records, location preference information, and specific data describing the instructor's performance and unique accomplishments relative to student groupings, specialized instructional methods, and subject matter areas. Pupil/teacher assignments could thus be improved, and personalized instruction obtained. The process could be refined through continuous upgrading from supervisory reports, questionnaires, student records, student opinion data, training records, and informal records. Implied in the adoption of MIS is the tenet that its primary mission is to support the teaching-learning process." (16, pp. 187-188)

It should be repeated that the mere keeping of records on students and teaching personnel does not constitute an MIS. Only if the data are related to system objectives in a meaningful way, and only if they can be processed and retrieved so as to yield pertinent information for decision-making, will they be useful in an MIS.

5.4 Research and development in instruction

The final use for management information systems to be discussed here is to provide an improved means for school personnel to obtain useful information about educational R & D. This has become an acute problem due to two factors: (1) the emphasis in the last five years on applying innovations in instruction to classroom practices, and (2) the increasing glut of R & D information, much of it in a form not easily translatable or useable by the classroom teacher.

> Effective use of R & D information under existing conditions requires the cooperation of many levels within the educational system. Initially, research and development is supported and/or performed by universities, foundations, and some school districts. The R & D results, however, are seldom in a form that can be applied directly in the schools; they must be summarized, interpreted, and translated into useable forms. These functions are imperfectly rendered by the curriculum specialist, who is becoming a less common feature at the district level while his role is becoming more important. (12, p. i)

To meet the need for dissemination of research and development information to schools, a number of systems have been developed. In many cases, they consist of rather elaborate data banks, with some attempt to supply abstracts or complete documents on general requests from teachers and others. Examples are ERIC (a national information service managed by the U. S. Office of Education, which has established 18 clearing houses), and EPIE (Educational Products Information Exchange).

The Far West Laboratory for Educational Research and Development made a study in 1968 of the system requirements of educational R & D. Among the operational and developmental systems which they analyzed were: (12, p. 34)

Educational Resources Information Center (ERIC) - U. S. Office of Education
Educational Products Information Exchange (EPIE) - Institute for Educational Development
School Research Information Service (SRIS) - Phi Delta Kappa
State Department of Education systems
Information System for Vocational Decisions - New England Educational Data System (NEEDS)
National Clearinghouse for Mental Health Information (NCMHI) - National Institute of Mental Health

5.4 Research and development in instruction

Science Information Centers Branch - National Institute for Child Health and Development (NICHD)
Defense Documentation Center
Clearinghouse for Federal Scientific and Technical Information (CFSTI) - U. S. Department of Commerce
National Library of Medicine
Science Information Exchange - Smithsonian Institution
National Referral Center for Science and Technology - Library of Congress
Data Banks - National Education Association (NEA), Project TALENT
NEA research summaries
Indexes, e.g., National Information Center for Educational Media, Grant Data Quarterly, Education Index
National, regional, and local libraries

The Far West Lab task force report found that the most serious failing of present information systems was "the almost total absence of interpreted and evaluated information available and useful to classroom teachers." (12, p. 23) The report suggested a model for a comprehensive R & D information system that would be directly useful to both general and specific requests of school personnel.

Fig. 40

A good short description of ERIC, EPIE, the National Referral Center, and SRIS is found in an article by Piele and Eidell in the Nation's Schools (25). The authors also discuss the ERIC Clearinghouse on Educational Administration (ERIC/CEA) which has been in operation at the University of Oregon since 1966. Its subject area is the leadership, management, and structure of public and private educational organizations on the elementary and secondary education levels. ERIC/CEA will soon begin to publish a series of papers analyzing current research findings on topics in educational administration.

5.4 Research and development in instruction

Many county school offices and most PACE Centers have the ERIC documents in microfilm with readers and reader/printers available. Administrators and teachers in the East Bay can use the Alameda County School Department's Curriculum Library, the Contra Costa PACE Center's information service, or the ERIC/Dialog computer on-line installation maintained in San Francisco by the regional office of the National Center for Educational Research and Development (formerly USOE Bureau of Research).

San Mateo County also maintains the Educational Resources Center which will supply answers on research questions to educators. The ERC has access to the entire ERIC collection as well as other research sources and many fugitive materials not available elsewhere. The Alameda County School Department has recently contracted for certain services with ERC through which educators may make requests, and other Bay Area counties may eventually join the system. Thus there is the capability present for a regional information system to answer research and development needs.

Thus far, such R & D information services have been used mostly by individuals to answer their own research needs in graduate study, develop project proposals, plan instructional innovations, and the like. There has been little attempt, however, to incorporate such services into a larger, integrated MIS.

6.5 THE ROLE OF COMPUTERS IN MIS

As has been stated before, the computer is only one component in an MIS. In a small organization, computers may not be necessary at all. It should be emphasized that educational data processing equipment does not in itself provide the system framework for management information.

Nor should an MIS be built around a particular piece of hardware and what it can deliver. The role of the computer is to store, process, and retrieve the information needed for management decision making. Only if it functions as a part of a well-planned system that serves the objectives for which it was designed, will it be useful and effective.

Goodlad has analyzed problems in educational planning appropriate for computer support in terms of three levels of processing and five categories of school information needs: (15, pp. 21-23)

LEVEL I Raw Data	LEVEL 2 Relationships Among Data	LEVEL 3 Decisions and Research
	GENERAL POLICY	
Codification and systemization of school laws, sources of funds, health and safety regulations, etc.	Effect of new policies on school health and safety records.	Study of relationships between policies and teacher and student effectiveness.
Results of polls on citizenship expectation for schools.	Patterns of relationships between subpublics and types of expectation for schools.	

6.0 The role of computers in MIS

LEVEL I Raw Data	LEVEL 2 Relationships Among Data	LEVEL 3 Decisions and Research
	Relationships among types of administrative problems and processes used in decision-making.	Conceptualization of possible new relationships and simulation of the consequences of effecting these relationships administratively.
	FACULTY, STAFF, AND STUDENTS	
Comprehensive inventories of teacher backgrounds.	Relationships between age, institution attended, credentials, etc., and teacher retention in the system.	
Long-term collections of data on student achievement, attendance, health, dropout, etc.	Relationships between school achievement and student health.	Prediction of student achievement in school from longitudinal data, followed by deliberate manipulation of the environment and analysis of the consequences.
	BUDGET AND FINANCIAL SUPPORT	
Statistics on school costs broken into budgeted categories.		
Maintenance of assessed evaluation statistics and data pertaining to proportion of district income spent on education	Relationships between financial support and various evidences of school productivity.	Decisions pertaining to school bond referendums and building construction in relation to alternative predictions of population growth and financial support, together with calculations pertaining to how much new industry will be attracted by new and better schools.

6.0 The role of computers in MIS

LEVEL I Raw Data	LEVEL 2 Relationships Among Data	LEVEL 3 Decisions and Research
	FACILITIES	
Cost statistics on all aspects of school construction and maintenance.	Relationships between costs of various types of construction and costs of maintenance.	Manipulation of facilities to test hypotheses growing out of observation at Level 2.
	CURRICULUM, INSTRUCTION, AND MATERIALS	
Number of students in various patterns of curriculum.	Relationships between student high school curricula and later academic and work careers.	
Student responses on programmed lessons and courses.	Relationships between responses and age, IQ, past achievement, etc.	Study of student learning styles and various provisions for them, such as different sizes and types of groups.
Storage and retrieval of data on student assignment to individual instruction, large groups, small groups, etc	Relationships between student assignment and various aspects of student success.	Manipulation of the instructional-grouping environment to test hypotheses growing out of observations at Level 2.

School district administrators at present are most concerned with the probable need for computers when PPBS becomes mandatory. At this time, no one knows what the costs will be for implementing PPBS. Although the basic data areas have been defined, the specific data element requirements have not yet been determined. For small districts, a PPB system can probably be operated without the use of computers, but the recording, processing, and reporting of information for districts of 2000 ADA or larger will probably necessitate automated data processing. (26, p. 24)

6.0 The role of computers in MIS

The California Educational Information System (CEIS) will provide EDP services at no programming costs to school districts of all sizes. In addition, CEIS will provide the capability for districts to do a more sophisticated analysis than would be possible with manual systems. CEIS subsystems are being designed to be used either with the traditional or PPBS approach. Price recommends that the development of computerized information systems to support PPBS be held in abeyance until the availability of the appropriate CEIS subsystems. (26, p. 24)

The advantages and disadvantages of computers in educational management were the subject of one portion of a workshop on information technology conducted in October, 1969, by the American Association of School Administrators (AASA), sponsor of the National Academy of School Executives (NASE). A number of experts from both education and corporations involved in computer systems discussed such matters as costs, control, and general uses. Price assembled some quotations from the following speakers: (26, pp. 13-15)

Dr. William Emerson, Superintendent, Oakland County Schools, Pontiac, Michigan
Dr. Burdette P. Hansen, Director, Measurement Research Corporation, Iowa City, Iowa
Dr. Arthur Lee Hardwick, Manager, Educational Systems Planning, RCA Educational Systems Division, Fort Worth, Texas
Dr. S. J. Knezevich, Director, AASA-NASE
Dr. Robert W. Marker, Vice President and Director of Educational Services, Westinghouse Learning Corporation, New York
Dr. George G. Tankard, Jr., Assistant Superintendent, Fairfax County Schools, Fairfax, Virginia
Mr. Peter Wahl, Director of Computer Operations, New England Educational Data Systems (NEEDS), Westinghouse Learning Corp., Waltham, Mass.

A few pertinent statements follow:

> You can't gain sophistication by the use of hardware technology alone. We haven't been able to ask the computers the right

questions to which we need the answers. You can't make sophisticated use of the hardware until you arrive at a sophisticated executive information system. (Knezevich)

Top management must get involved in setting up the system and directing priorities. This cannot be delegated. An information system is not a product; it is a direction. You can never have a total information system. The smarter you get, the stupider you realize you are. (Tankard)

It is necessary to set the objectives for the information system in advance. One then gets the equipment to implement it. (Marker)

The school must control the programmer, must decide on what it wants and insist that it gets it. Don't let the hardware dictate what you want in the way of information. (Hardwick)

Consortiums of districts are in trouble because the center tells people what they can put through the machines. Centers need to be more responsive to the needs of the clients. (Marker)

The California system is in trouble because it is viewed as a state information system. It has been doomed to failure from the start because it is not serving the people at the local level. If it does not meet the needs at the local level, people will fight it. (Marker)

Costs of a comprehensive mangement information system are ungodly high. They cannot be judged on a cost basis. (Wahl)

No educational group has really put together a cost effective system utilizing a computer. (Hansen)

The initial input to get data is expensive, but if the data is reused for a variety of purposes, the cost goes down. (Marker)

Hardware costs are going down. This is partially the result of 'unbundling' the cost of the system. However, since software and people costs are going up, the overall cost of the system is remaining relatively stable. (Wahl)

Most districts are too small for computers, and consortiums of districts are not working very successfully. Although systems are not operating as well as we would like to see

> them operate, they are better than nothing. This can also be said for other educational programs. One of the main problems is that everybody wants to operate his own. (Emerson)
>
> Little machines mean a 'little guy' operating them. This won't get you what you need from the machines. (Knezevich)
>
> The reason why smaller districts don't move into EDP is because it costs too much. However, cost is relative. (Knezevich)
>
> We need larger units with local adaptation of the system. At the present time, there is no truly satisfactory answer anywhere in the United States. (Marker)
>
> If we are going to use the computer as a cost effective tool for decision making, we must use it for more than just quantitative data on budgets, teachers, buildings, and so on. The 'something else' is that it must be tied to the classroom. (CAI is most effective with special education, which is expensive anyway.) (Marker)
>
> Most materials coming out of information systems are not useable for decision making. There must be an integrated system with information integrated into the total management system. (Hansen)

Price summarizes the value of using a computer in the various stages of the information process in Figure 41.

Fig. 41

One of the advantages of the use of a computer in a management information system is that data from many levels of school organization and many programs can be fed from separate files into a central system and then disseminated to the people who need it much more quickly than it can be done by hand. For example, in one county-wide vocational training and guidance program that was analyzed by the writer, it was found that data from assessment procedures that were made for new students were so late in coming back to the teachers and special counselors in the program, that students were half-way through the courses before their real needs were known. Of course, the use of a computer does not automatically solve this problem, for if it is not integrated properly with the entire system, the system may become overloaded and there will still be too great a lag between the time of assessment and time of retrieval of the information. It may be weeks before new information is processed, summarized, transmitted, and made available to the people who need it for operations and decisions.

It is a moot question as to whether the centralization of information will automatically result in the centralization of control. If used properly, it can streamline operations, and could give a school system a new coherence and sense of unity. As Greenberger states:

> Much has been written about the dangers that may lie in wait for the computerized society; the cult of the machine, over-delegation of our activities to the computer, too much faith in its simplifications and quantifications, the invasion of privacy and individual rights by over-zealous programs of industry or government, criminal misuses of the computer. These possibilities are real and should not be waved aside. Computer scientists take them seriously and are today in an uncomfortable position somewhat like that of the nuclear physicists after the discovery of uranium fission.
>
> It should be perfectly clear, however, that the dangers arise from the way man may use the computer, not from the machine itself. The computer remains under human control. The programs of the future will have the character man designs into them, and prevention of abuses is an important part of the design problem. (18, pp. 155-156)

7.0 CONCLUSIONS

Four facts should be kept in mind regarding management information systems:

1. Computers and other hardware are only components of information systems.
2. The administrator or manager should be sure that information systems are asked to sell the right products.
3. It should be recognized that technological changes in the information sciences have not altered the general nature of system development processes.
4. Information systems, if they are well designed, can provide the needed responses to profound challenges of the contemporary era. (29, Chap. XI)

Rosove quotes a remark made by Norbert Wiener at MIT several years ago, that he could build a computer which would be able to duplicate itself. Vannever Bush commented, "But it is possible to visualize a machine in the desert, surrounded by its numerous progeny, busily computing all sorts of things to which no one is paying any attention whatever." (29, p. 350)

It is the design of the MIS, rather than the physical attributes of its components, which is critical. If there is no such design, but merely components endlessly producing themselves, will anyone be paying attention?

Many of the problems and difficulties encountered in educational activities related to MIS as well as to any system development are traceable to the attitudes, customs, and institutionalized inertia of the users. Diebold's observation of the businessman's approach to the creation of information systems is applicable here:

> Truly fruitful results from information handling systems require a fundamental change in approach, an understanding that the best applications come not from the mechanization or streamlining of existing procedures, but are based on

> management's willingness to rethink the problems of an entire business in terms of ultimate goal and final product. These are not technical problems. They are problems of definition of objectives and assessments of markets, of method, organization, and attitude. (10, p. 351)

At present in California there are a number of unrelated components of MIS available to educators at the state, regional, or local levels, including various prepackaged commercial and non-commercial systems, data processing centers, and information retrieval facilities for research. As the public demand for accountability increases, and as administrators accept the necessity for planned change and renewal in education to meet emerging student needs, it becomes apparent that these piecemeal solutions are not enough. Information science and its accompanying technology, if used with imagination in a problem-solving context, hold the possibility for a new and fruitful approach to dealing with educational management and decision making.

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APPENDIX

FIGURES

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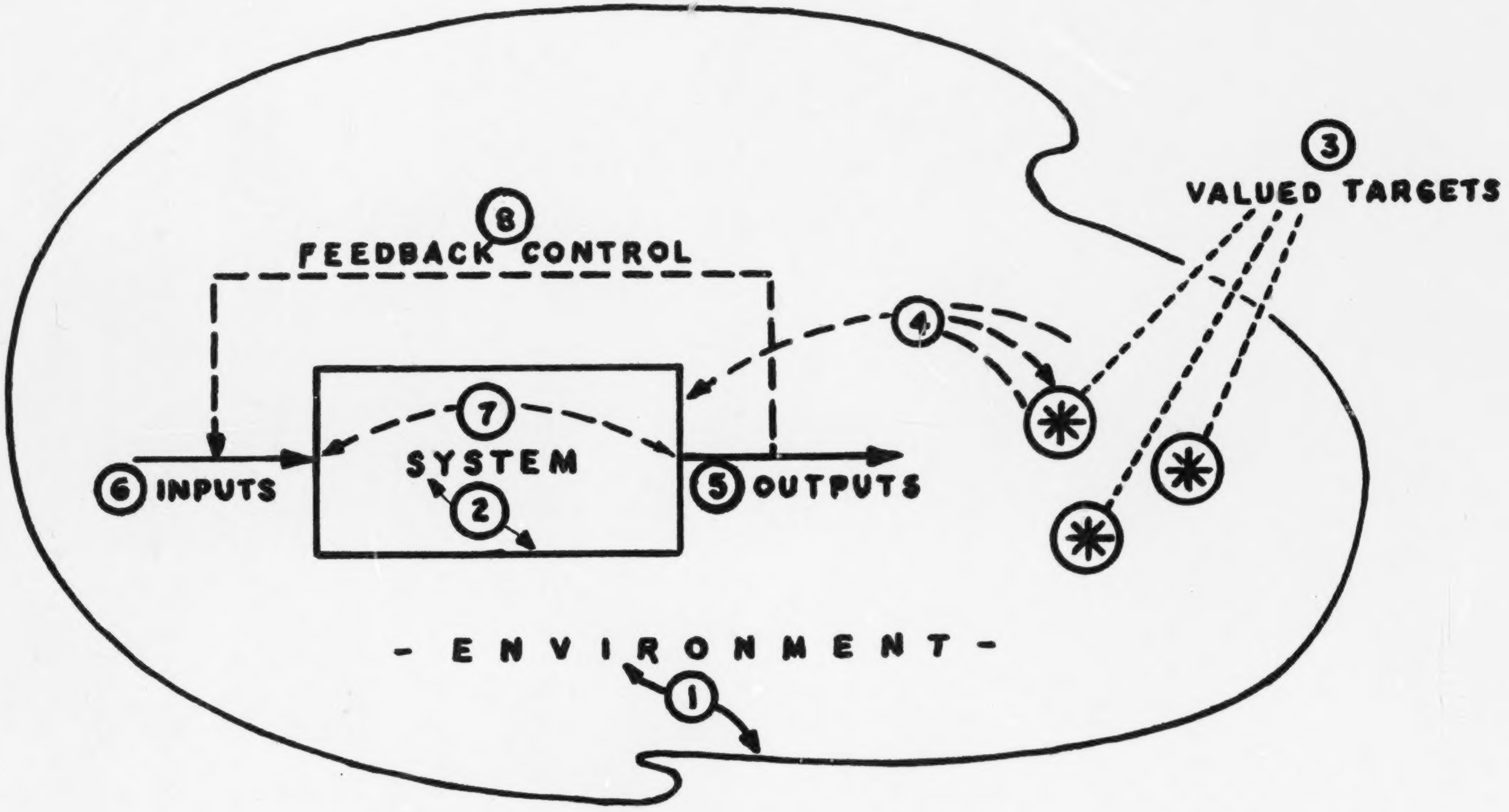
FIGURE I -- MODEL OF A SYSTEM


③
VALUED TARGETS
⑧
FEEDBACK CONTROL
④
⑦
SYSTEM
②
⑥ INPUTS
⑤ OUTPUTS
- ENVIRONMENT -
①

CONSIDERATIONS IN THE DEVELOPMENT OF A STRATEGY FOR SYSTEM DESIGN AND/OR SYSTEM STUDY

FIGURE 2

FUNCTIONAL FLOW BLOCK DIAGRAM OF A SYSTEM
MODEL FOR EDUCATIONAL PROBLEM SOLVING

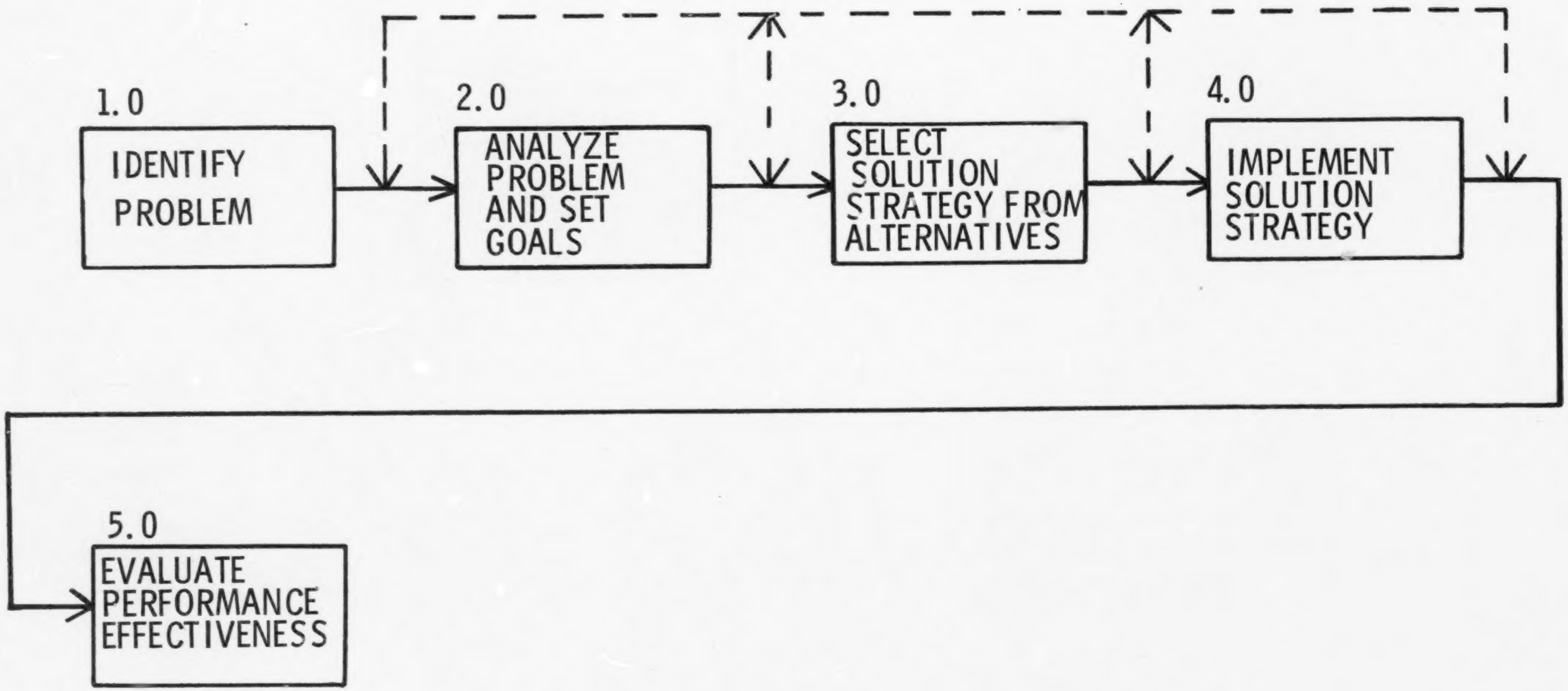

1.0
IDENTIFY PROBLEM
2.0
ANALYZE PROBLEM AND SET GOALS
3.0
SELECT SOLUTION STRATEGY FROM ALTERNATIVES
4.0
IMPLEMENT SOLUTION STRATEGY
5.0
EVALUATE PERFORMANCE EFFECTIVENESS

FIGURE 3

SYSTEM ANALYSIS AND SYSTEM SYNTHESIS

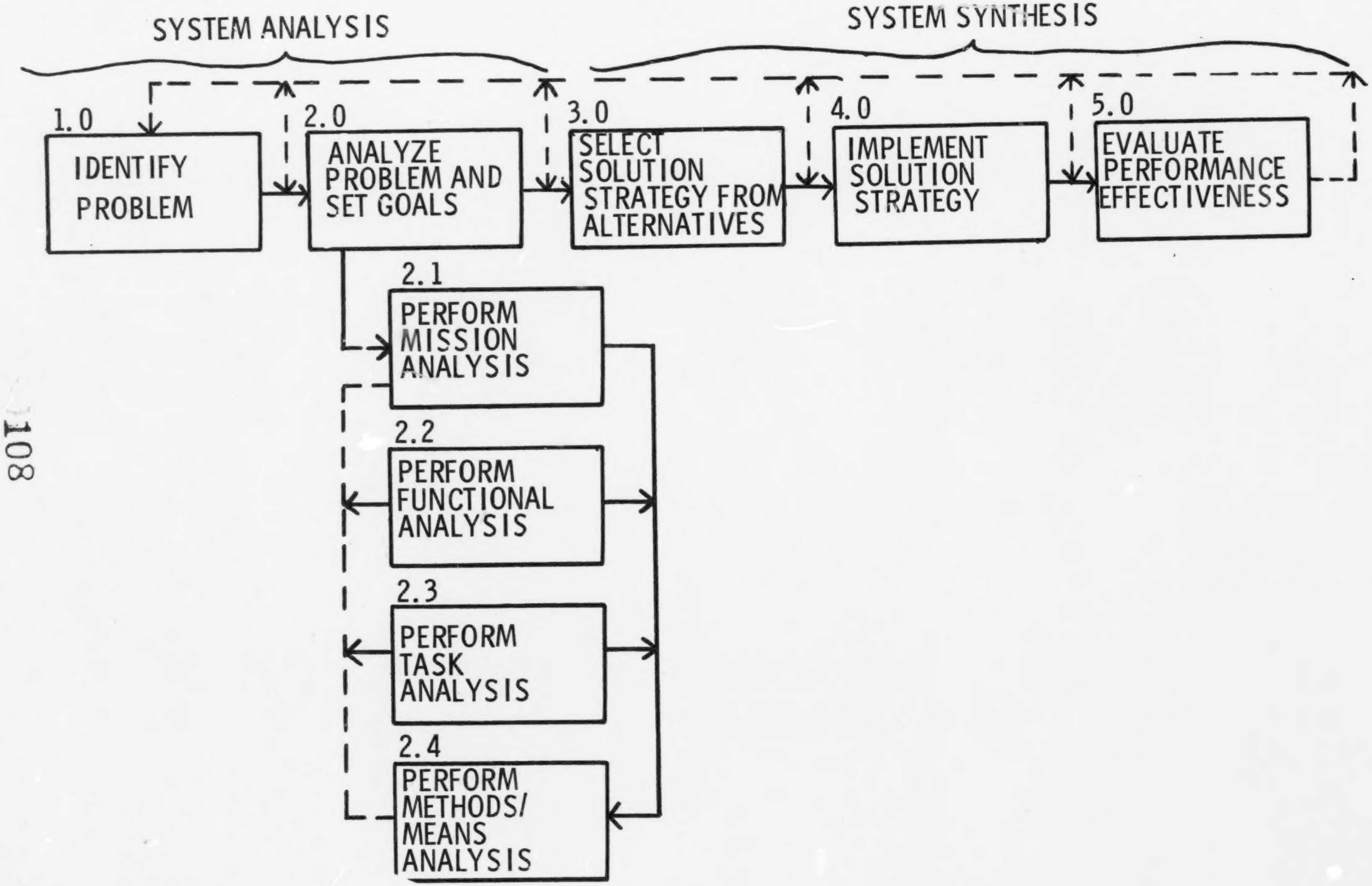
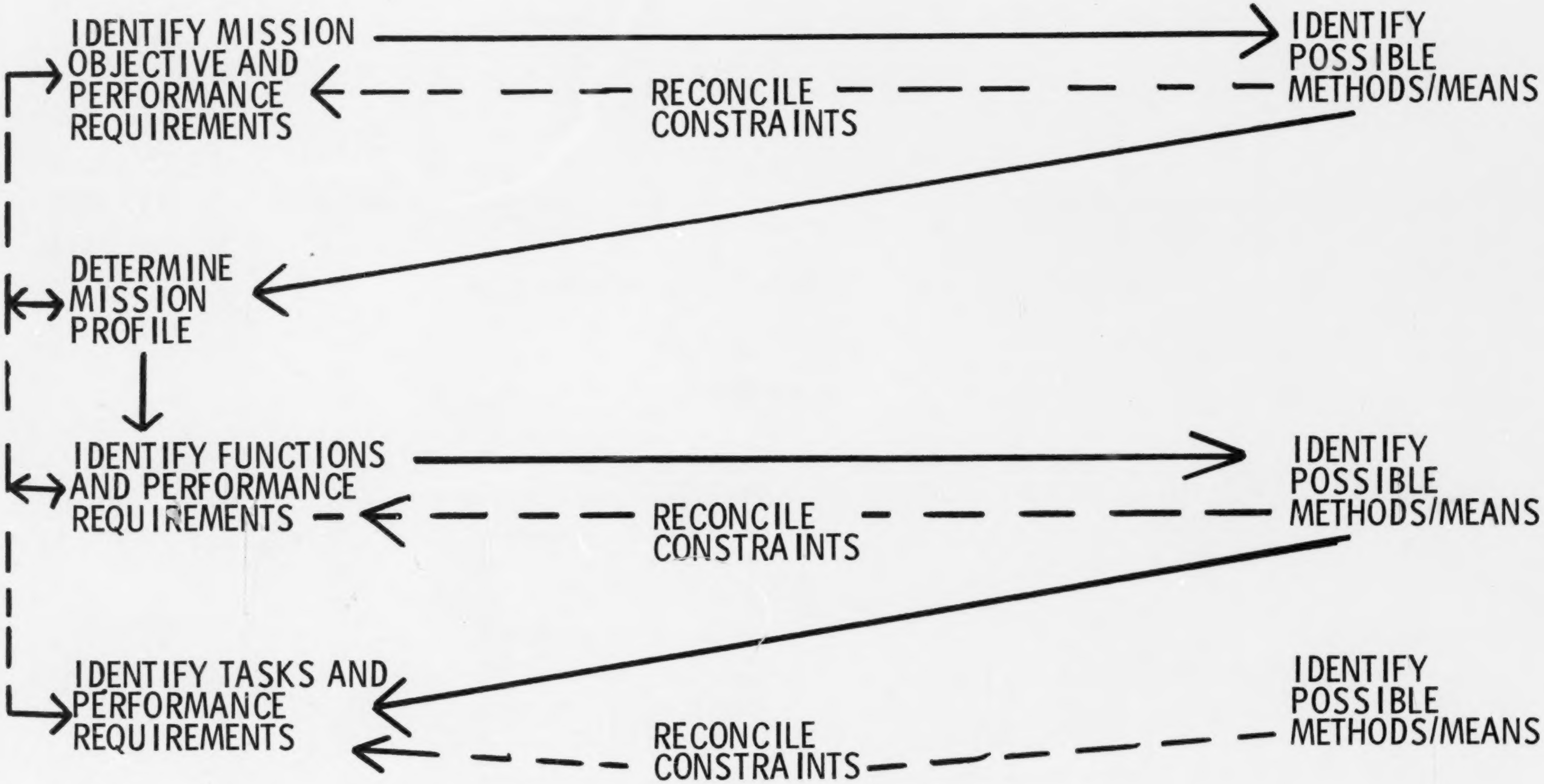

SYSTEM ANALYSIS
SYSTEM SYNTHESIS
1.0
IDENTIFY PROBLEM
2.0
ANALYZE PROBLEM AND SET GOALS
3.0
SELECT SOLUTION STRATEGY FROM ALTERNATIVES
4.0
IMPLEMENT SOLUTION STRATEGY
5.0
EVALUATE PERFORMANCE EFFECTIVENESS
2.1
PERFORM MISSION ANALYSIS
2.2
PERFORM FUNCTIONAL ANALYSIS
2.3
PERFORM TASK ANALYSIS
2.4
PERFORM METHODS/ MEANS ANALYSIS

FIGURE 4 -- PROCESS MODEL


IDENTIFY MISSION OBJECTIVE AND PERFORMANCE REQUIREMENTS
IDENTIFY POSSIBLE METHODS/MEANS
RECONCILE CONSTRAINTS
DETERMINE MISSION PROFILE
IDENTIFY FUNCTIONS AND PERFORMANCE REQUIREMENTS
IDENTIFY POSSIBLE METHODS/MEANS
RECONCILE CONSTRAINTS
IDENTIFY TASKS AND PERFORMANCE REQUIREMENTS
IDENTIFY POSSIBLE METHODS/MEANS
RECONCILE CONSTRAINTS

A system analysis process model which identifies the relationship between the various steps in the process.

Note that a continuous feasibility check is being made during the process by identifying requirements in the mission, functional and task analysis and determining if there are any methods/means available for accomplishing each performance requirement or family of performance requirements.

FIGURE 5

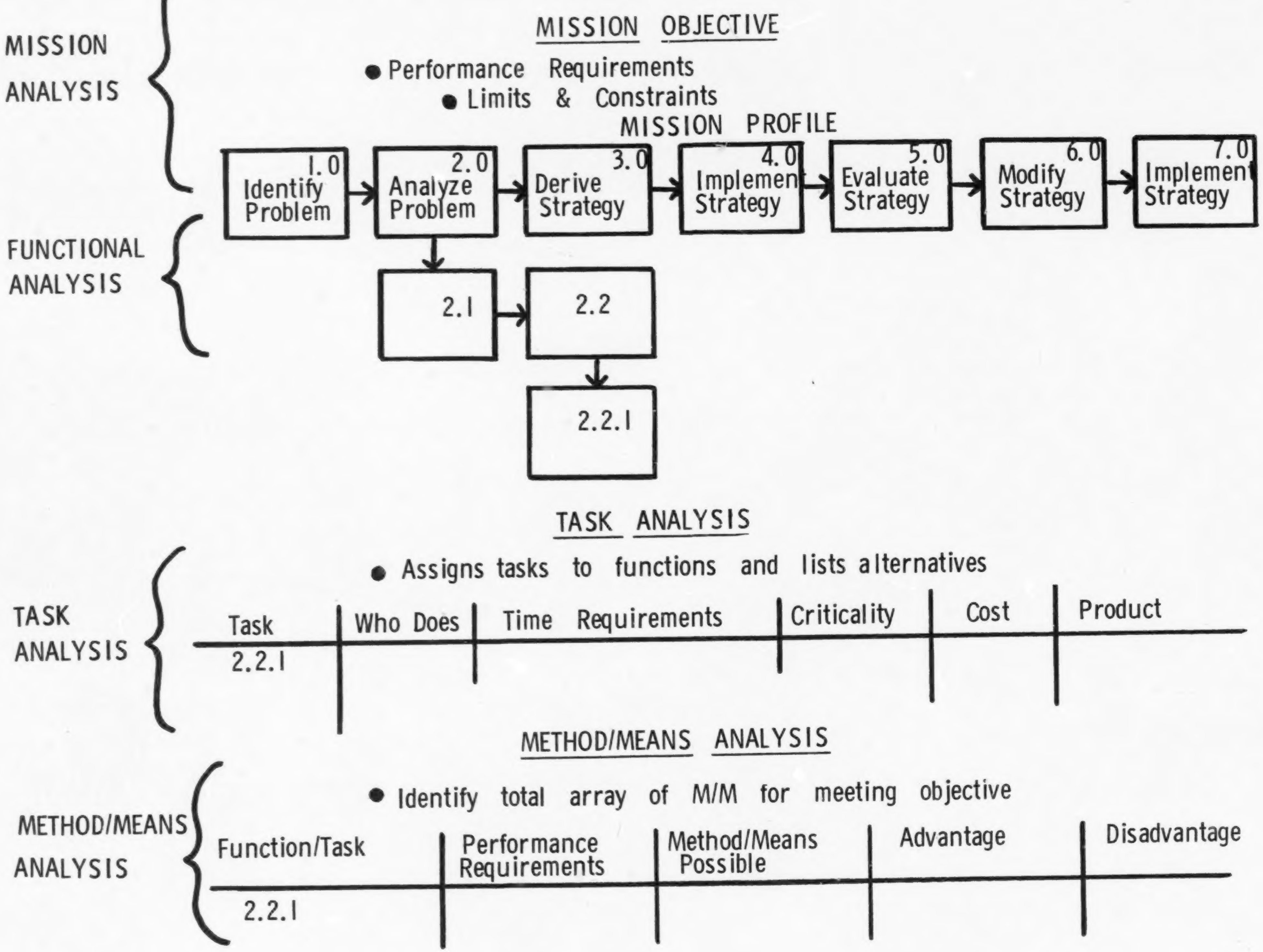
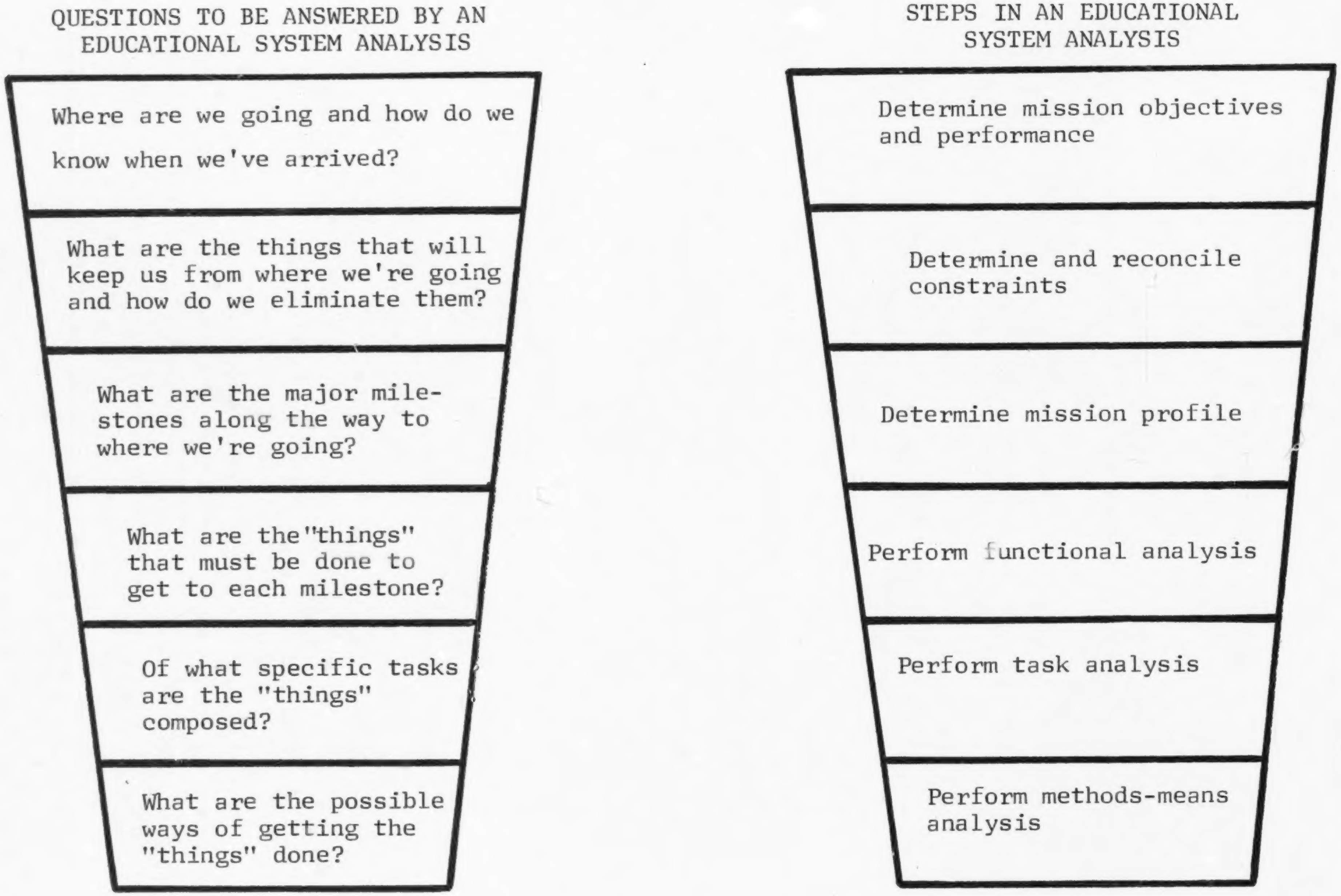

MISSION ANALYSIS
MISSION OBJECTIVE
● Performance Requirements
● Limits & Constraints
MISSION PROFILE
1.0 Identify Problem
2.0 Analyze Problem
3.0 Derive Strategy
4.0 Implement Strategy
5.0 Evaluate Strategy
6.0 Modify Strategy
7.0 Implement Strategy
FUNCTIONAL ANALYSIS
2.1
2.2
2.2.1
TASK ANALYSIS
TASK ANALYSIS
● Assigns tasks to functions and lists alternatives
Task
2.2.1
Who Does
Time Requirements
Criticality
Cost
Product
METHOD/MEANS ANALYSIS
METHOD/MEANS ANALYSIS
● Identify total array of M/M for meeting objective
Function/Task
2.2.1
Performance Requirements
Method/Means Possible
Advantage
Disadvantage

FIGURE 6

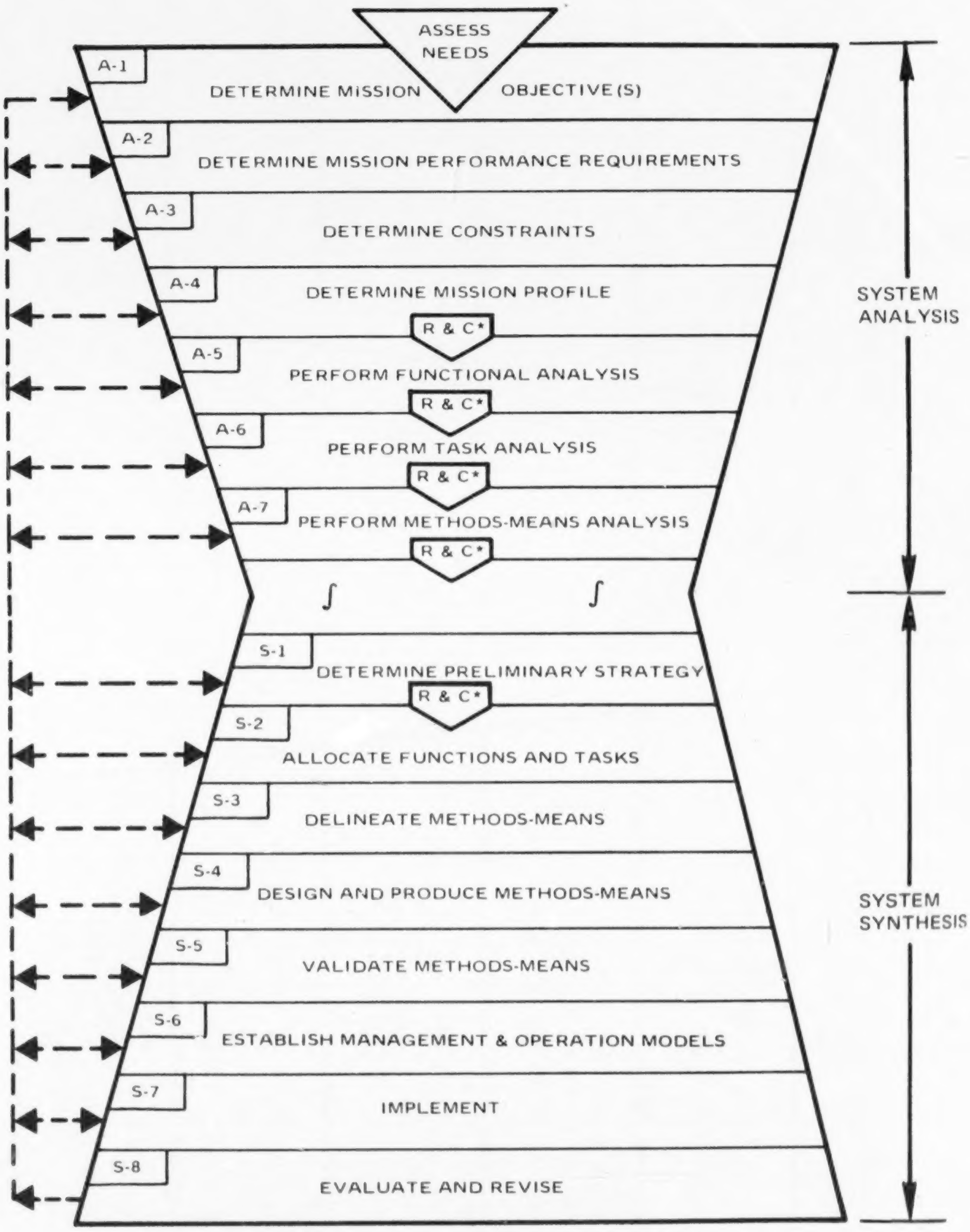


QUESTIONS TO BE ANSWERED BY AN EDUCATIONAL SYSTEM ANALYSIS	STEPS IN AN EDUCATIONAL SYSTEM ANALYSIS
Where are we going and how do we know when we've arrived?	Determine mission objectives and performance
What are the things that will keep us from where we're going and how do we eliminate them?	Determine and reconcile constraints
What are the major milestones along the way to where we're going?	Determine mission profile
What are the "things" that must be done to get to each milestone?	Perform functional analysis
Of what specific tasks are the "things" composed?	Perform task analysis
What are the possible ways of getting the "things" done?	Perform methods-means analysis

The questions to be answered in a system analysis and their relation to the steps of performing a system analysis.

FIGURE 7

A MODEL OF A SYSTEM APPROACH FOR EDUCATION (SAFE)


ASSESS NEEDS
A-1
DETERMINE MISSION OBJECTIVE(S)
A-2
DETERMINE MISSION PERFORMANCE REQUIREMENTS
A-3
DETERMINE CONSTRAINTS
A-4
DETERMINE MISSION PROFILE
R & C*
A-5
PERFORM FUNCTIONAL ANALYSIS
R & C*
A-6
PERFORM TASK ANALYSIS
R & C*
A-7
PERFORM METHODS-MEANS ANALYSIS
R & C*
S-1
DETERMINE PRELIMINARY STRATEGY
R & C*
S-2
ALLOCATE FUNCTIONS AND TASKS
S-3
DELINEATE METHODS-MEANS
S-4
DESIGN AND PRODUCE METHODS-MEANS
S-5
VALIDATE METHODS-MEANS
S-6
ESTABLISH MANAGEMENT & OPERATION MODELS
S-7
IMPLEMENT
S-8
EVALUATE AND REVISE
SYSTEM ANALYSIS
SYSTEM SYNTHESIS

*DETERMINE REQUIREMENT AND CONSTRAINTS

FIGURE 8

A SYSTEM MODEL FOR INFORMATION FLOW IN MIS

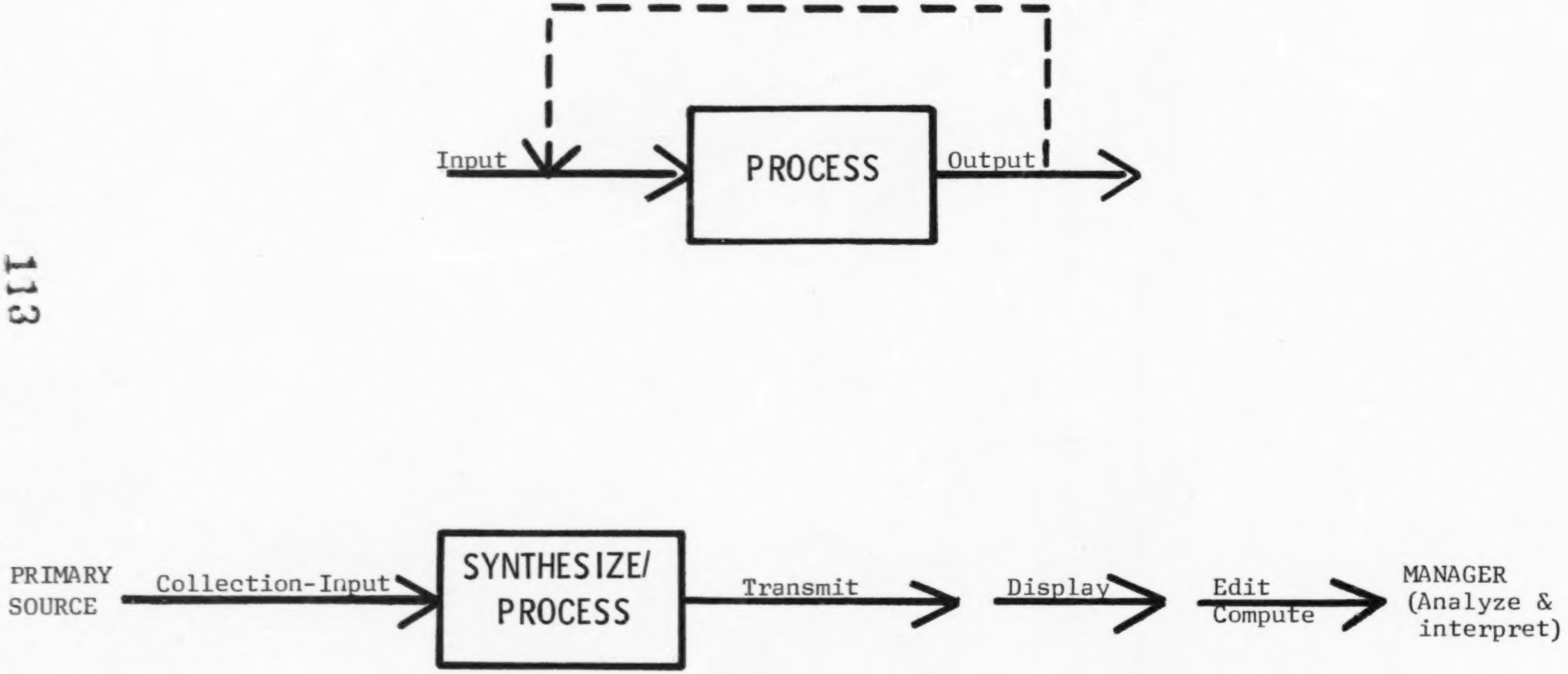

Input
PROCESS
Output
PRIMARY SOURCE
Collection-Input
SYNTHESIZE/ PROCESS
Transmit
Display
Edit
Compute
MANAGER (Analyze & interpret)

FIGURE 9

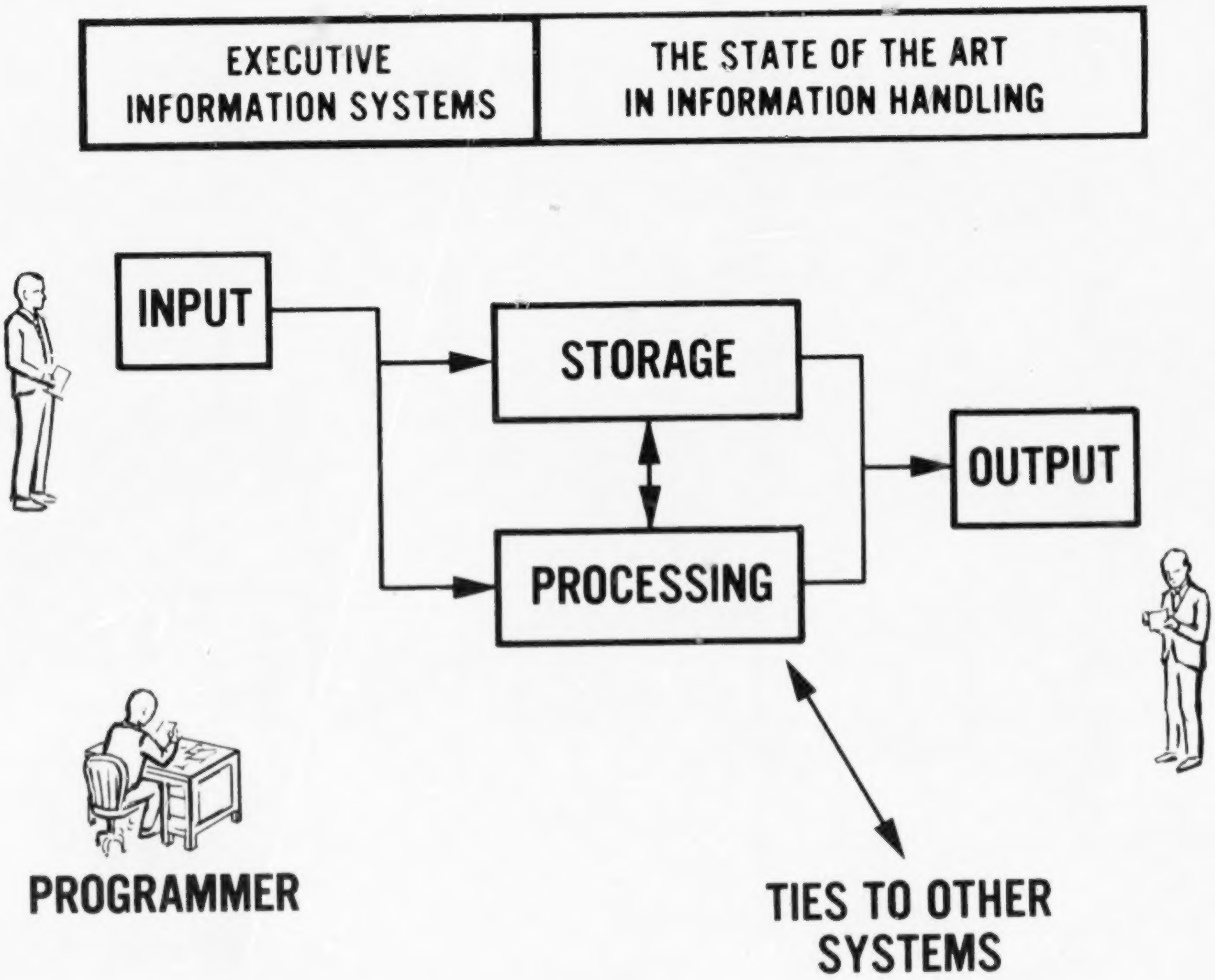

EXECUTIVE INFORMATION SYSTEMS
THE STATE OF THE ART IN INFORMATION HANDLING
INPUT
STORAGE
PROCESSING
OUTPUT
PROGRAMMER
TIES TO OTHER SYSTEMS

FIGURE 10

RELATION OF MIS TO PPBS

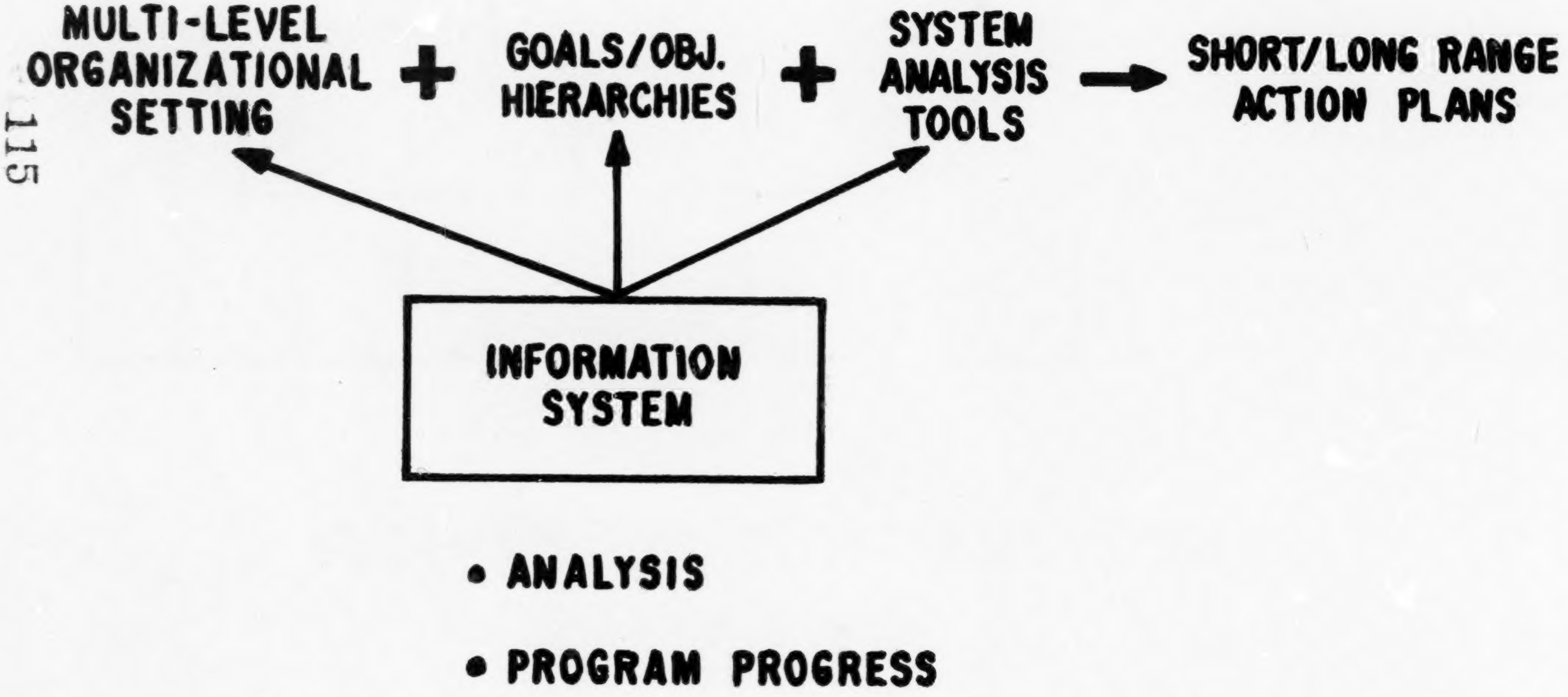

MULTI-LEVEL ORGANIZATIONAL SETTING
+
GOALS/OBJ. HIERARCHIES
+
SYSTEM ANALYSIS TOOLS
SHORT/LONG RANGE ACTION PLANS
INFORMATION SYSTEM
• ANALYSIS
• PROGRAM PROGRESS

FIGURE 11 -- PPBS

PROGRAM STRUCTURE HIERARCHY

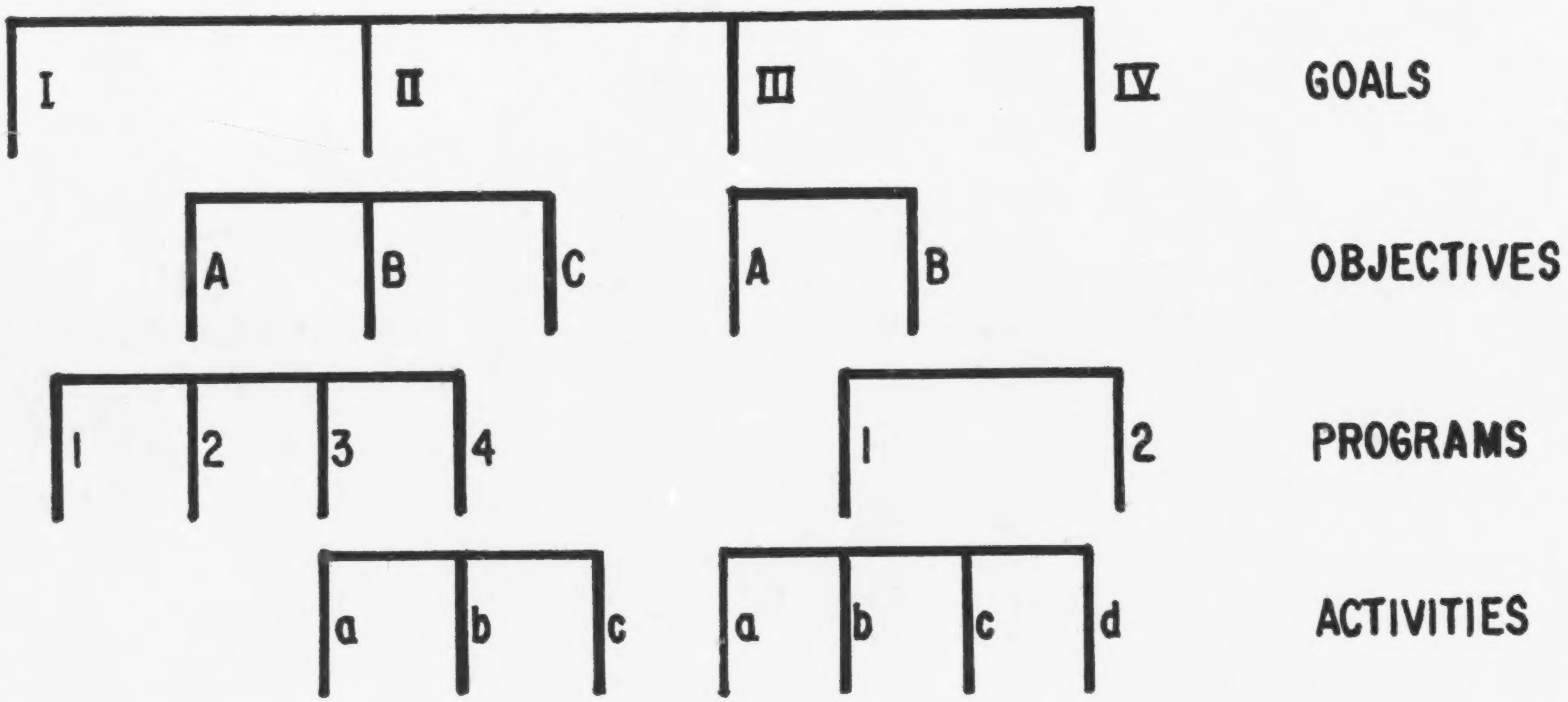
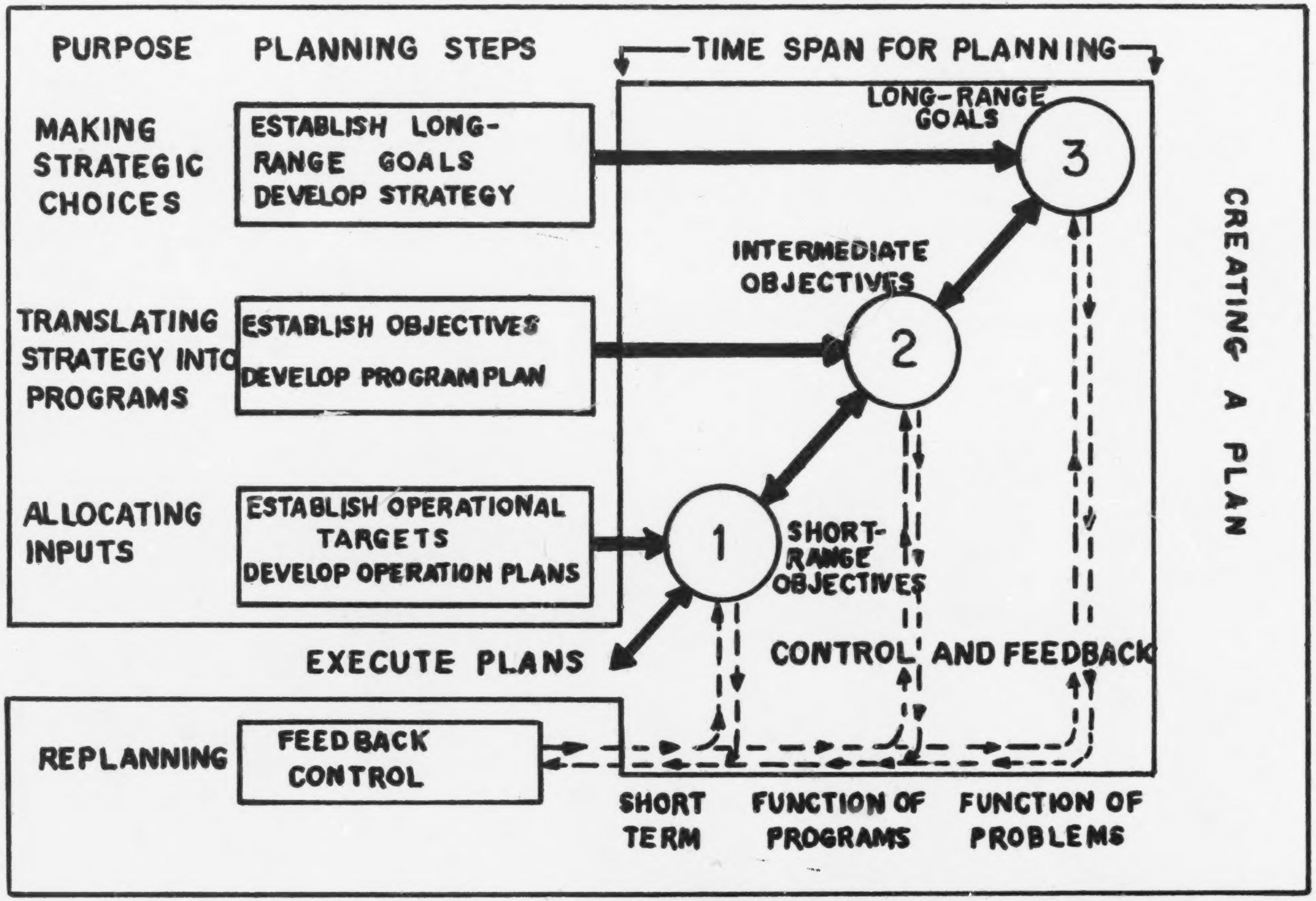

I
II
III
IV
GOALS
A
B
C
A
B
OBJECTIVES
1
2
3
4
1
2
PROGRAMS
a
b
c
a
b
c
d
ACTIVITIES

FIGURE 12 -- A SYSTEM FOR COMPRHENSIVE PLANNING


PURPOSE
PLANNING STEPS
TIME SPAN FOR PLANNING
CREATING A PLAN
MAKING STRATEGIC CHOICES
ESTABLISH LONG-RANGE GOALS
DEVELOP STRATEGY
TRANSLATING STRATEGY INTO PROGRAMS
ESTABLISH OBJECTIVES
DEVELOP PROGRAM PLAN
ALLOCATING INPUTS
ESTABLISH OPERATIONAL TARGETS
DEVELOP OPERATION PLANS
EXECUTE PLANS
REPLANNING
FEEDBACK CONTROL
LONG-RANGE GOALS
3
INTERMEDIATE OBJECTIVES
2
SHORT-RANGE OBJECTIVES
1
CONTROL AND FEEDBACK
SHORT TERM
FUNCTION OF PROGRAMS
FUNCTION OF PROBLEMS

1. ACHIEVEMENT OF SHORT-RANGE TARGETS WITHIN TIME-COST-PERFORMANCE REQUIREMENTS
2. INCREMENTAL PROGRESS TOWARDS ACCOMPLISHING LONG-RANGE GOALS.
3. ACHIEVEMENT OF LONG—RANGE GOALS

Adapted from
Raymond E. Kitchell

FIGURE 13

MATRIX ORGANIZATION CHART FOR SCHOOL DISTRICT

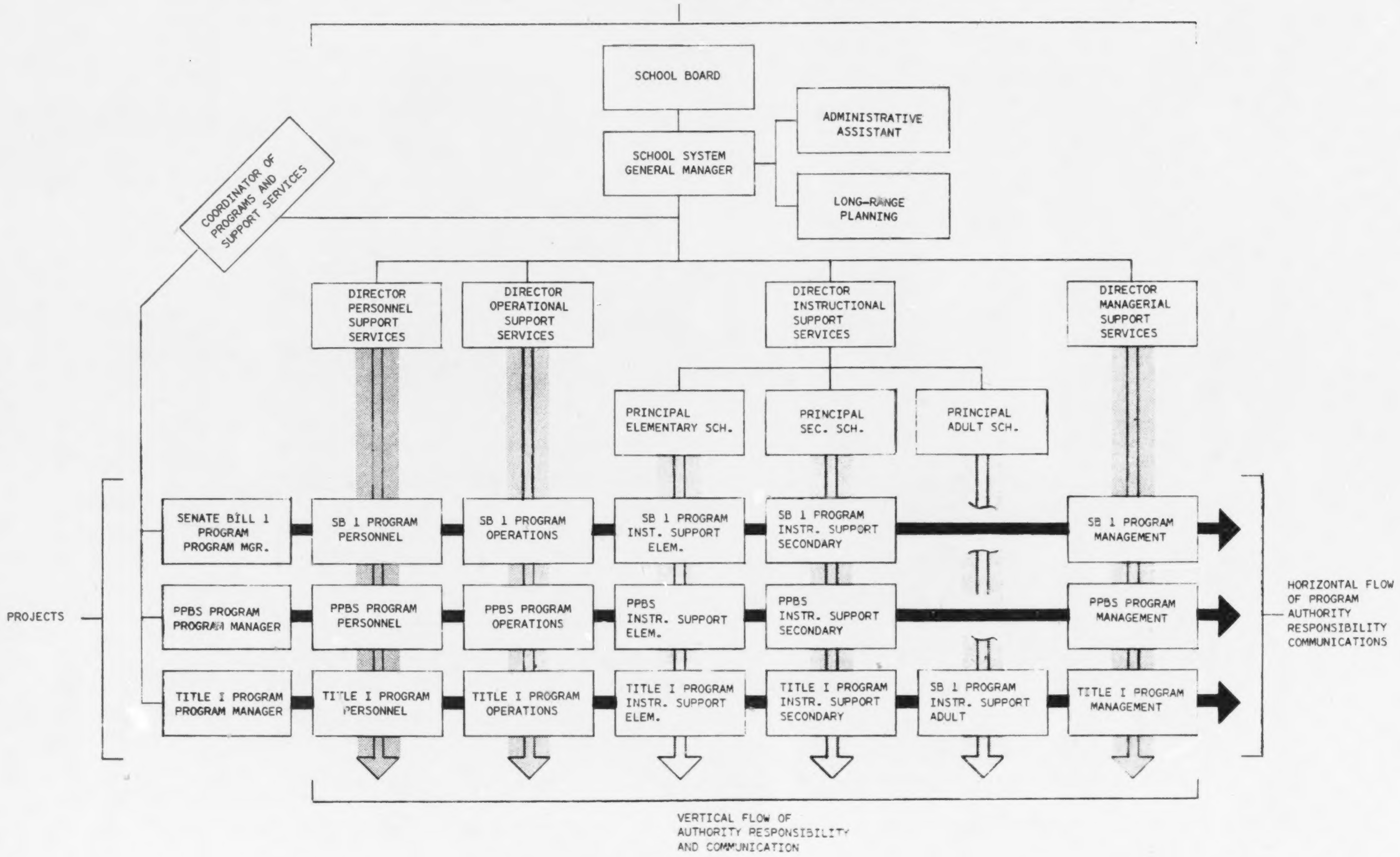
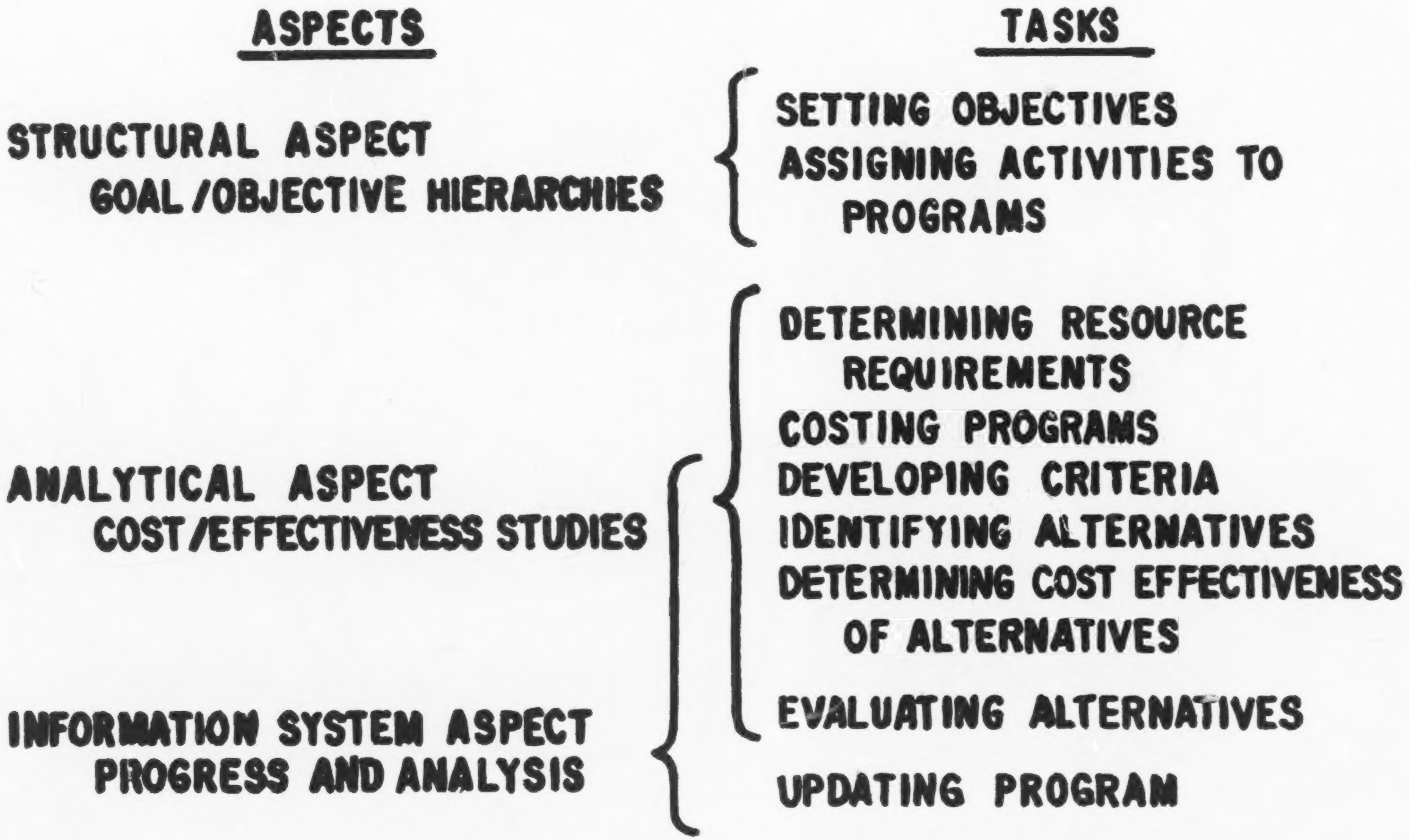

SCHOOL BOARD
SCHOOL SYSTEM GENERAL MANAGER
ADMINISTRATIVE ASSISTANT
LONG-RANGE PLANNING
COORDINATOR OF PROGRAMS AND SUPPORT SERVICES
DIRECTOR PERSONNEL SUPPORT SERVICES
DIRECTOR OPERATIONAL SUPPORT SERVICES
DIRECTOR INSTRUCTIONAL SUPPORT SERVICES
DIRECTOR MANAGERIAL SUPPORT SERVICES
PRINCIPAL ELEMENTARY SCH.
PRINCIPAL SEC. SCH.
PRINCIPAL ADULT SCH.
SENATE BILL 1 PROGRAM PROGRAM MGR.
SB 1 PROGRAM PERSONNEL
SB 1 PROGRAM OPERATIONS
SB 1 PROGRAM INST. SUPPORT ELEM.
SB 1 PROGRAM INSTR. SUPPORT SECONDARY
SB 1 PROGRAM MANAGEMENT
PPBS PROGRAM PROGRAM MANAGER
PPBS PROGRAM PERSONNEL
PPBS PROGRAM OPERATIONS
PPBS INSTR. SUPPORT ELEM.
PPBS INSTR. SUPPORT SECONDARY
PPBS PROGRAM MANAGEMENT
TITLE I PROGRAM PROGRAM MANAGER
TITLE I PROGRAM PERSONNEL
TITLE I PROGRAM OPERATIONS
TITLE I PROGRAM INSTR. SUPPORT ELEM.
TITLE I PROGRAM INSTR. SUPPORT SECONDARY
SB 1 PROGRAM INSTR. SUPPORT ADULT
TITLE I PROGRAM MANAGEMENT
PROJECTS
HORIZONTAL FLOW OF PROGRAM AUTHORITY RESPONSIBILITY COMMUNICATIONS
VERTICAL FLOW OF AUTHORITY RESPONSIBILITY AND COMMUNICATION

FIGURE 14

PPBS ASPECTS AND TASKS INVOLVED



ASPECTS

STRUCTURAL ASPECT
GOAL /OBJECTIVE HIERARCHIES

ANALYTICAL ASPECT
COST /EFFECTIVENESS STUDIES

INFORMATION SYSTEM ASPECT
PROGRESS AND ANALYSIS

TASKS

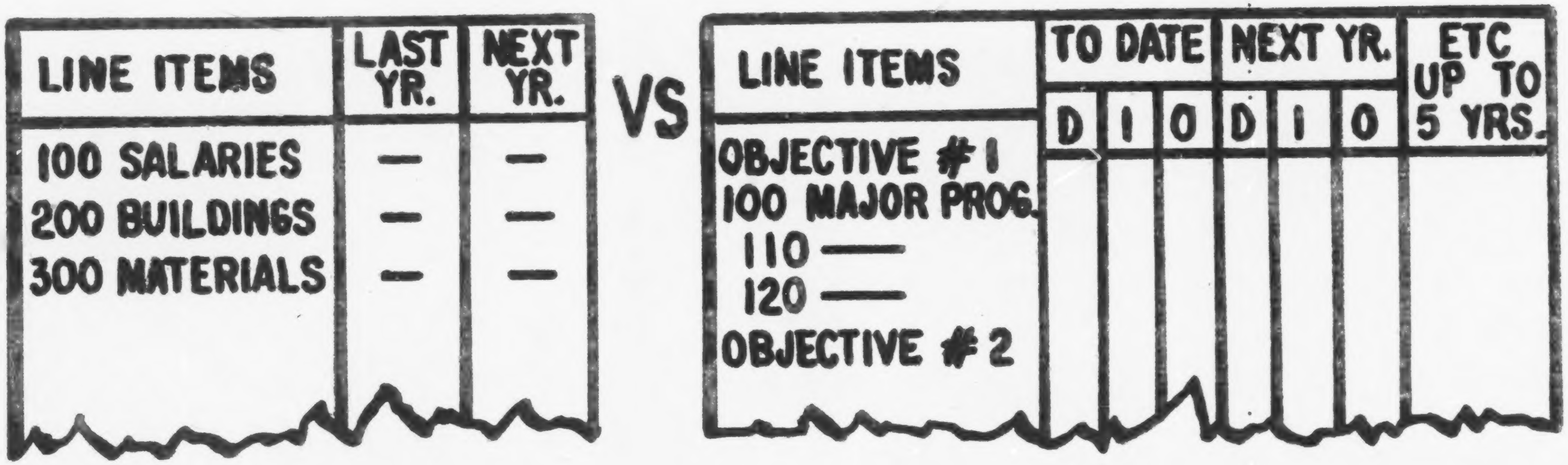
SETTING OBJECTIVES
ASSIGNING ACTIVITIES TO PROGRAMS

DETERMINING RESOURCE REQUIREMENTS
COSTING PROGRAMS
DEVELOPING CRITERIA
IDENTIFYING ALTERNATIVES
DETERMINING COST EFFECTIVENESS OF ALTERNATIVES
EVALUATING ALTERNATIVES

UPDATING PROGRAM

FIGURE 15

TRADITIONAL BUDGET VS. PROGRAM BUDGET



LINE ITEMS	LAST YR.	NEXT YR.
100 SALARIES	—	—
200 BUILDINGS	—	—
300 MATERIALS	—	—

VS

LINE ITEMS	TO DATE			NEXT YR.			ETC UP TO 5 YRS.
	D	I	O	D	I	O	
OBJECTIVE # 1							
100 MAJOR PROG.							
110 ——							
120 ——							
OBJECTIVE # 2							

PROBLEMS -

- SHORT REVIEW PERIOD
- CLARITY OF OBJECTIVES ?
- ACCOMPLISHMENTS ?
- ALTERNATIVES ?
- FUTURE COSTS AND IMPACTS ?
- LITTLE ANALYSIS / PLANNING

= POLITICAL PARALYSIS —
CHAOS ⟷ RIGIDITY - CRISIS

FIGURE 16

A FRAMEWORK FOR THE EVOLUTIONARY DEVELOPMENT OF MIS

ORGANIZATIONAL CONTEXT

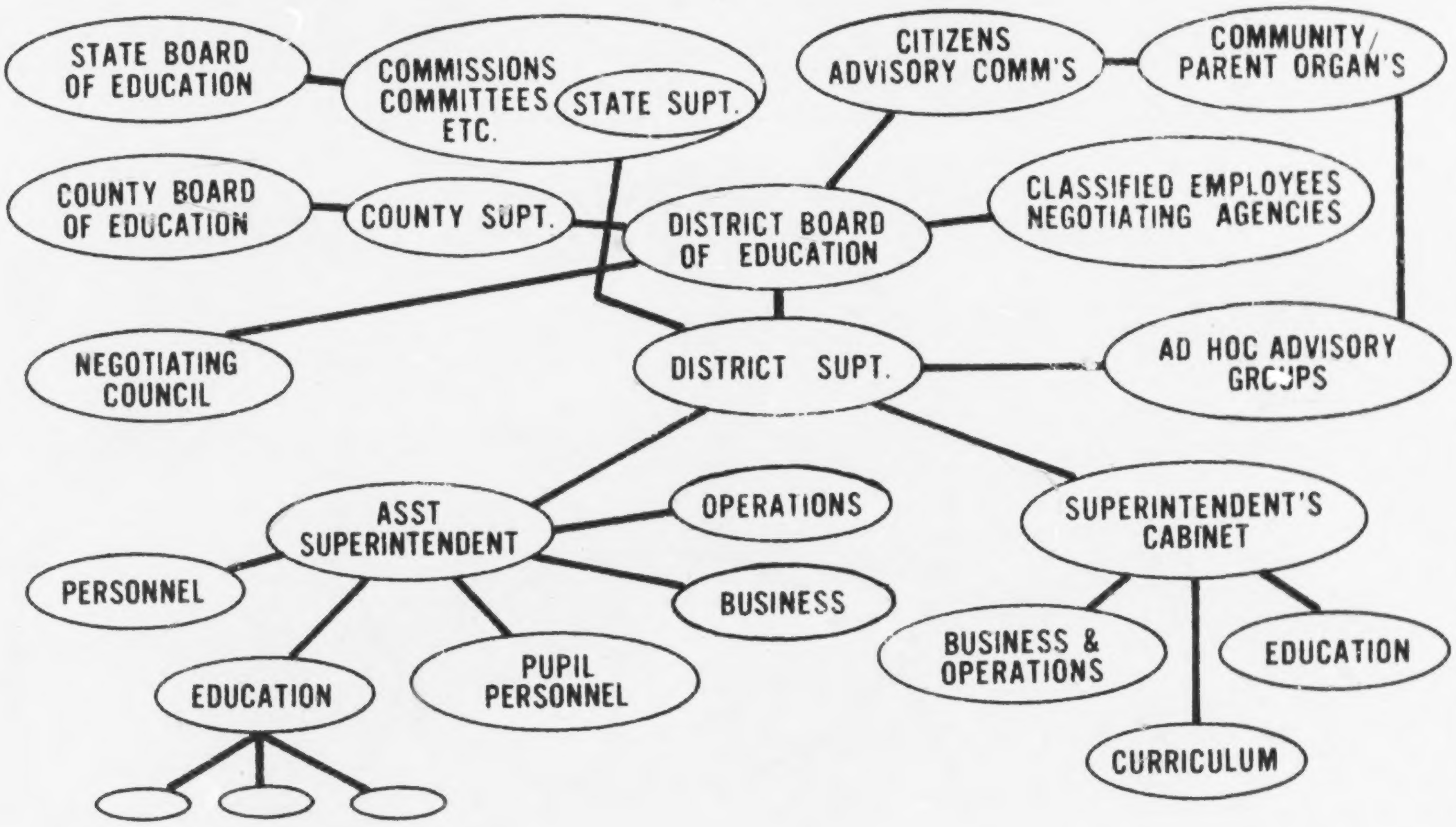
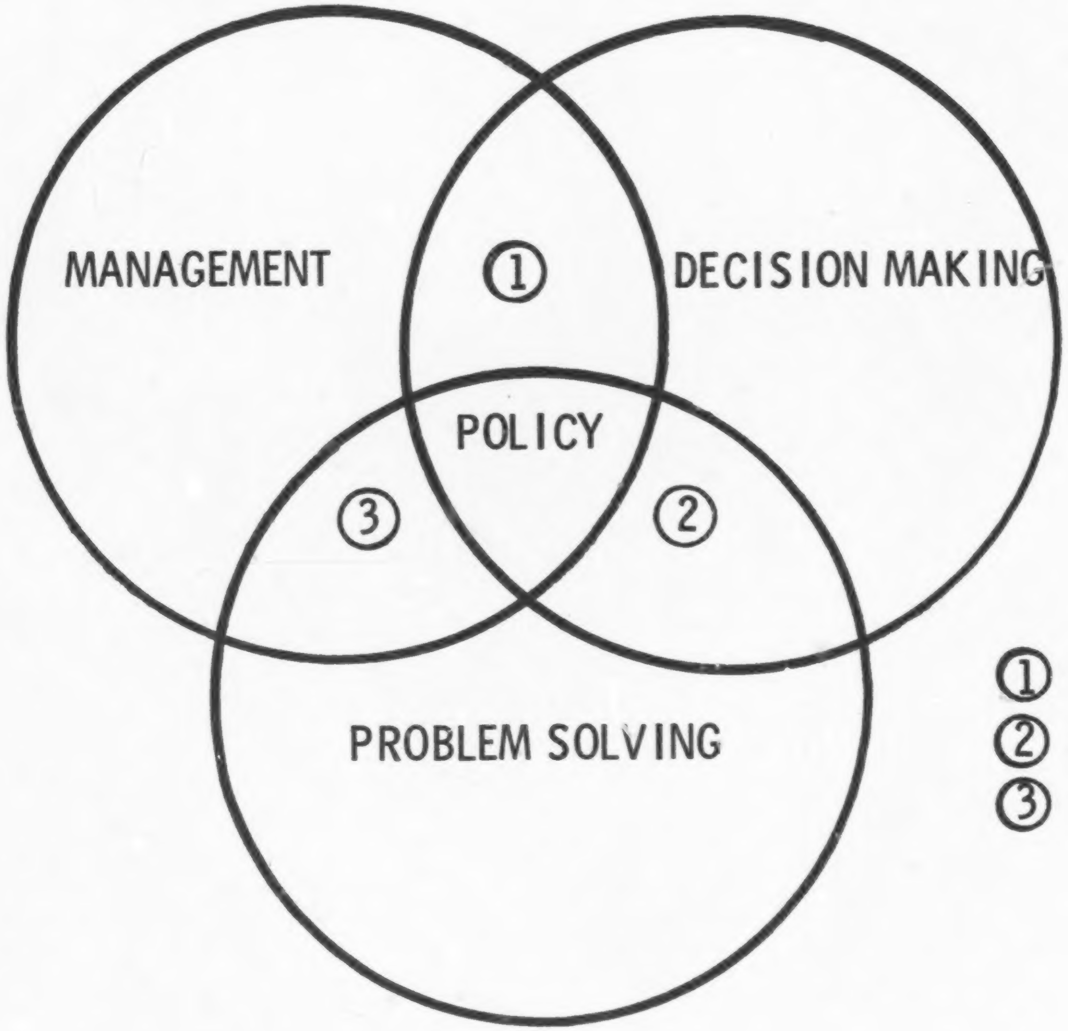

STATE BOARD OF EDUCATION
COMMISSIONS COMMITTEES ETC.
STATE SUPT.
CITIZENS ADVISORY COMM'S
COMMUNITY/ PARENT ORGAN'S
COUNTY BOARD OF EDUCATION
COUNTY SUPT.
DISTRICT BOARD OF EDUCATION
CLASSIFIED EMPLOYEES NEGOTIATING AGENCIES
NEGOTIATING COUNCIL
DISTRICT SUPT.
AD HOC ADVISORY GROUPS
ASST SUPERINTENDENT
OPERATIONS
SUPERINTENDENT'S CABINET
PERSONNEL
BUSINESS
BUSINESS & OPERATIONS
EDUCATION
EDUCATION
PUPIL PERSONNEL
CURRICULUM

FIGURE 17

A MODEL OF ORGANIZATIONAL POLICY RELATIONS


MANAGEMENT
①
DECISION MAKING
POLICY
③
②
PROBLEM SOLVING

KEY POLICY RELATIONS

① MANAGEMENT AND DECISION MAKING
② DECISION MAKING AND PROBLEM SOLVING
③ PROBLEM SOLVING AND MANAGEMENT

FIGURE 18

AN EXPANDED MODEL OF EDUCATIONAL POLICY RELATIONS

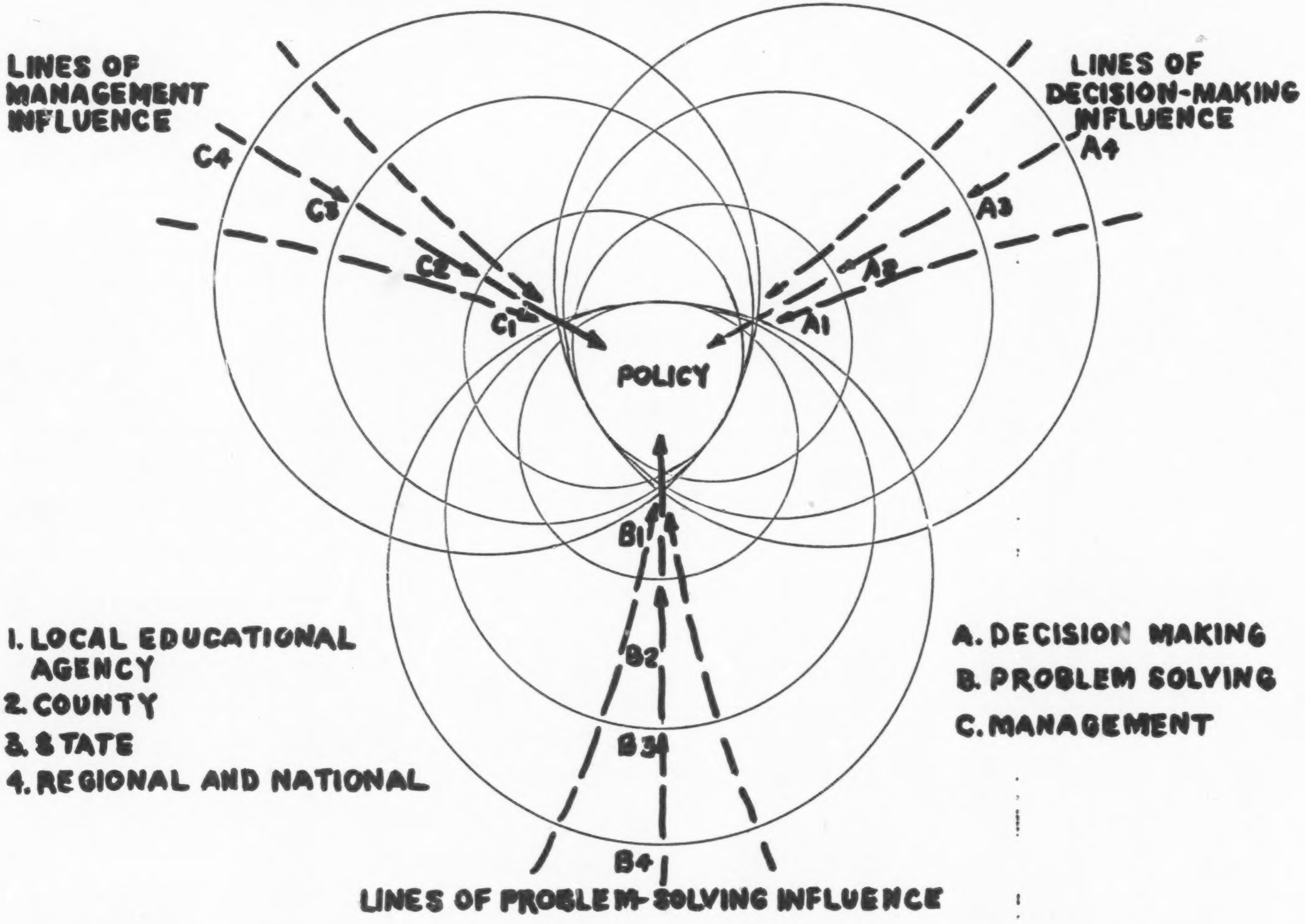
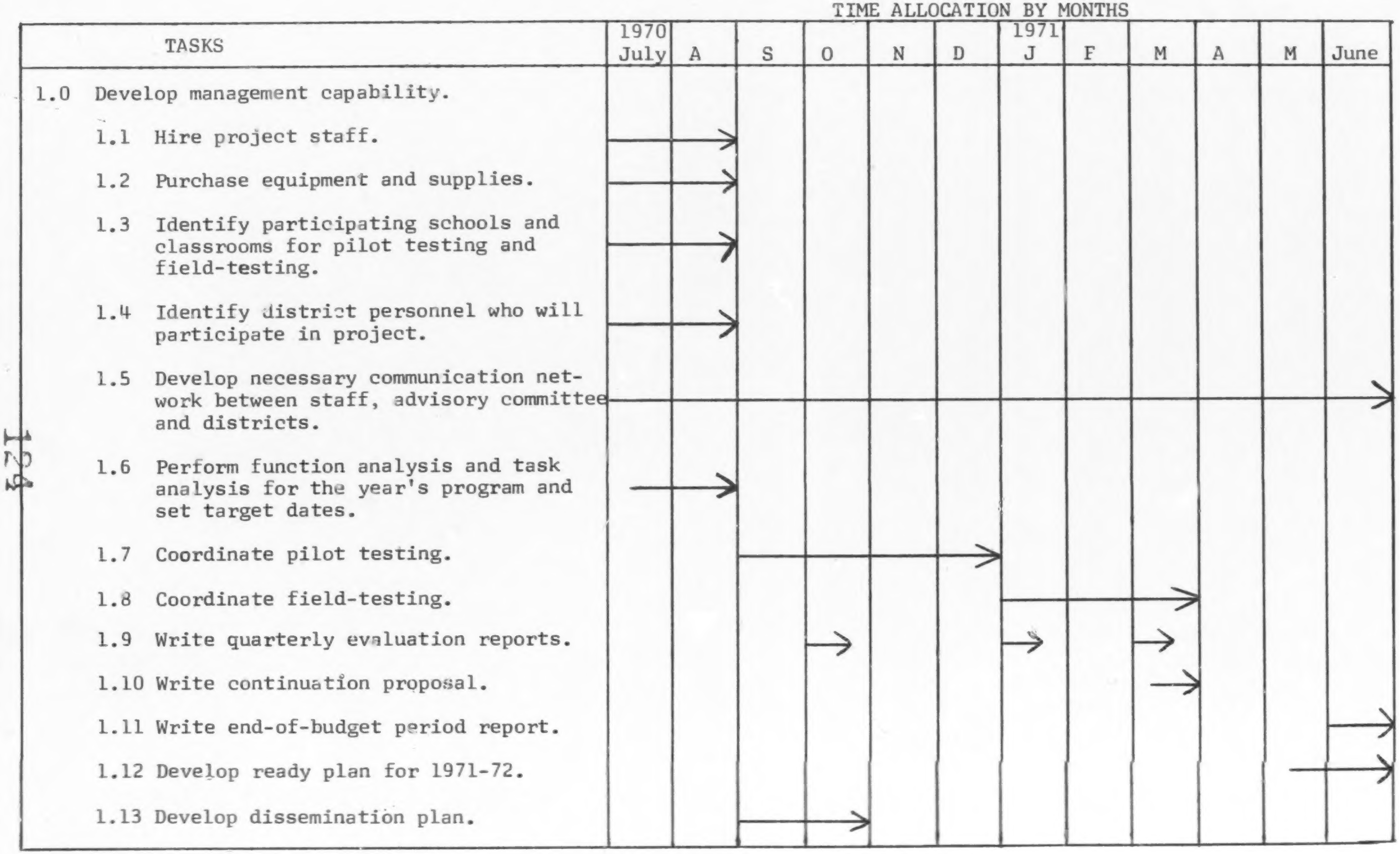

LINES OF MANAGEMENT INFLUENCE
LINES OF DECISION-MAKING INFLUENCE
C4
C3
C2
C1
A4
A3
A2
A1
POLICY
B1
B2
B3
B4
1. LOCAL EDUCATIONAL AGENCY
2. COUNTY
3. STATE
4. REGIONAL AND NATIONAL
A. DECISION MAKING
B. PROBLEM SOLVING
C. MANAGEMENT
LINES OF PROBLEM-SOLVING INFLUENCE

FIGURE 19

GANTT CHART FOR *AUDITORY PERCEPTUAL TRAINING PROJECT



*Alameda County Superintendent of Schools, ESEA Title III project.

FIGURE 20

MILESTONE CHART FOR AUDITORY PERCEPTUAL PROJECT

	TIME ALLOCATION BY MONTHS											
TASKS	July	A	S	O	N	D	J	F	M	A	M	June
1. Develop vocabulary and behavioral objectives.		△										
2. Develop scripts.			△				△					
3. Produce student work sheets.				△								
4. Produce prototype tape recordings.						△		△				
5. Produce teachers' manuals.						△			△			
6. Complete pilot test - Phase I.									△			
7. Complete pilot test - Phase II.											△	
8. Consultants monitor project.								△	△		△	
9. Conduct teacher workshops.							△		△			
10. Complete evaluation and revision of program.												△

FIGURE 21

ALTERNATE FORM FOR MILESTONE CHART

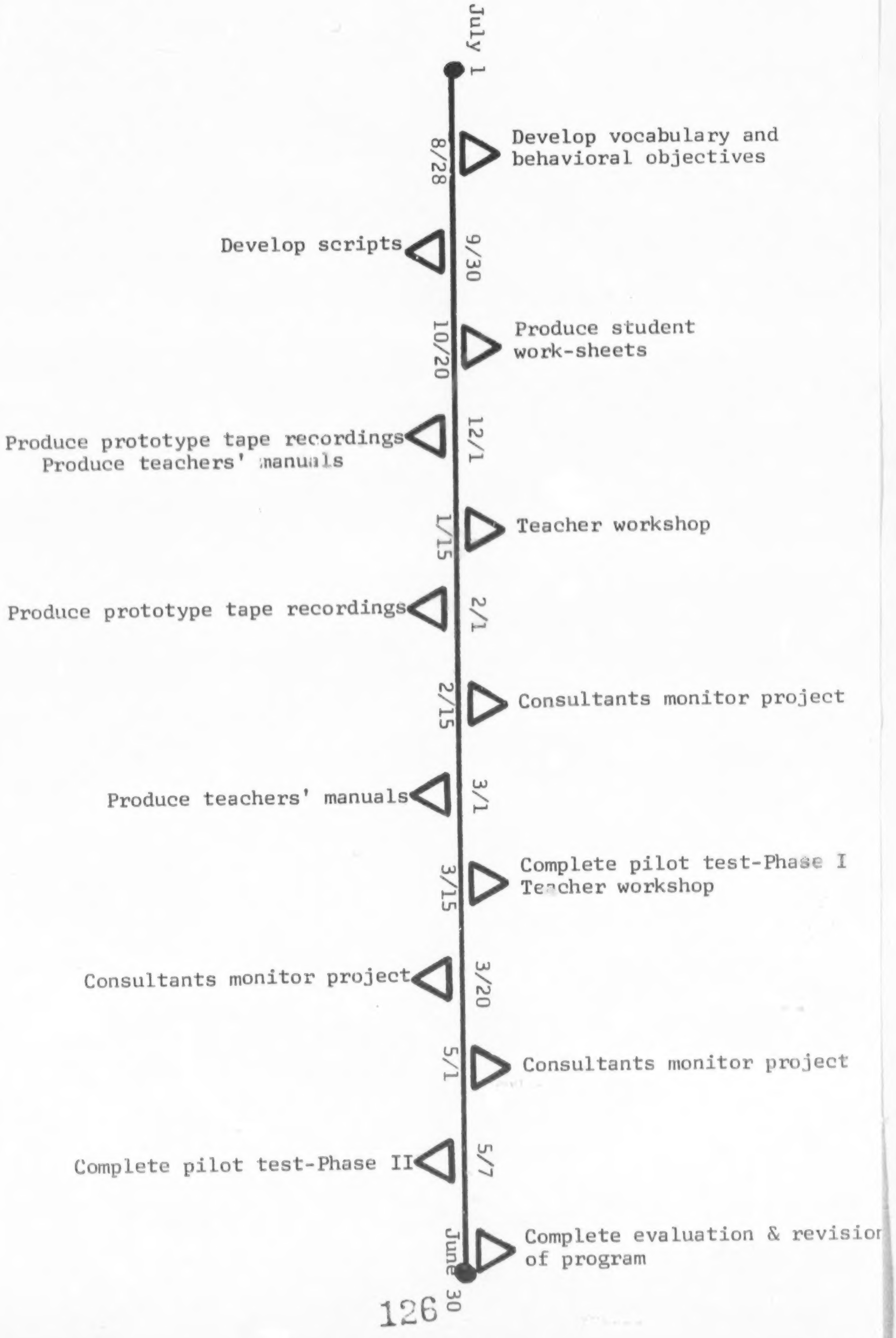

July 1
8/28
Develop vocabulary and behavioral objectives
9/30
Develop scripts
10/20
Produce student work-sheets
12/1
Produce prototype tape recordings
Produce teachers' manuals
1/15
Teacher workshop
2/1
Produce prototype tape recordings
2/15
Consultants monitor project
3/1
Produce teachers' manuals
3/15
Complete pilot test-Phase I
Teacher workshop
3/20
Consultants monitor project
5/1
Consultants monitor project
5/7
Complete pilot test-Phase II
June 30
Complete evaluation & revisior of program

FIGURE 22

EVOLUTION OF THE NETWORK PLAN

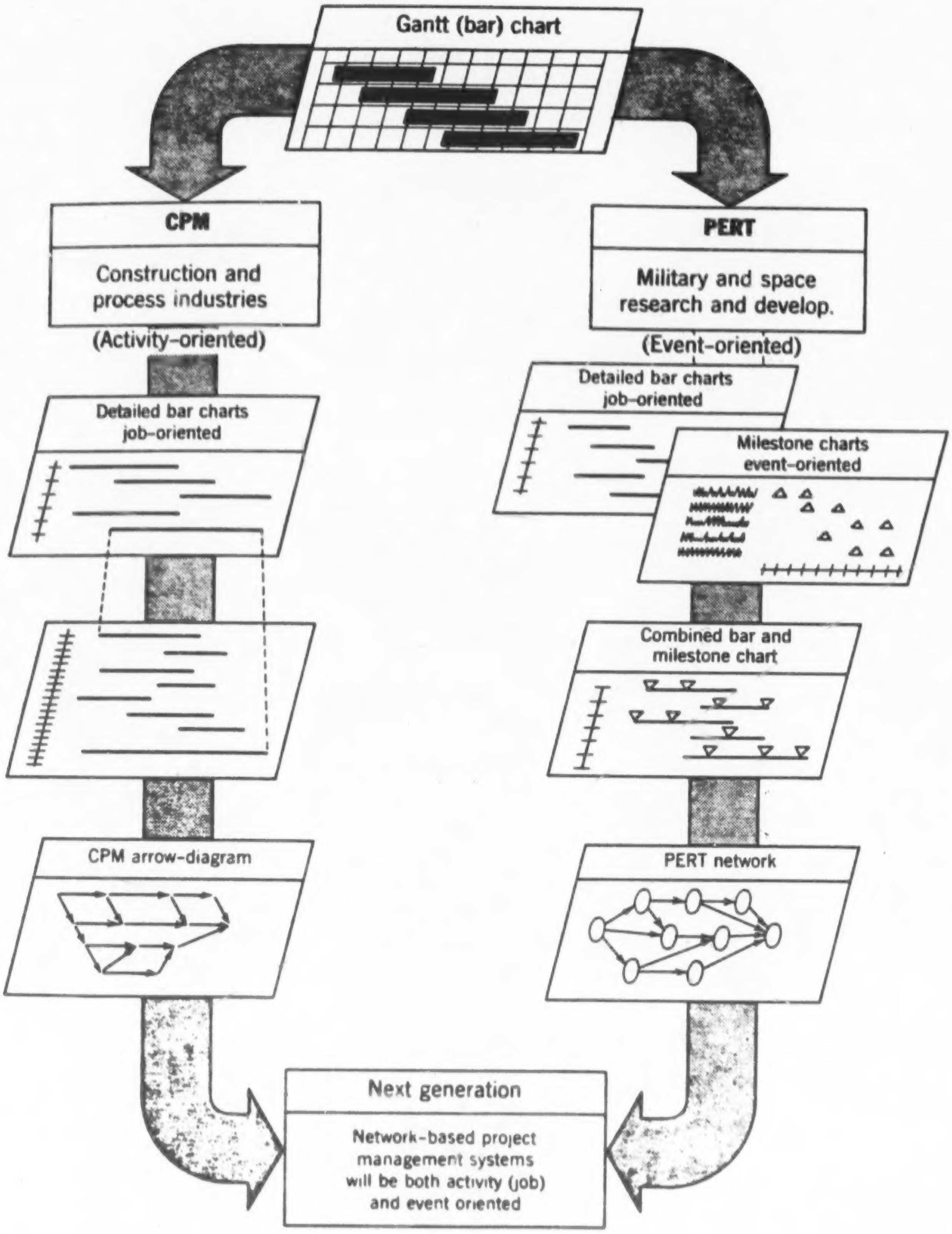

Gantt (bar) chart
CPM
Construction and process industries
(Activity-oriented)
PERT
Military and space research and develop.
(Event-oriented)
Detailed bar charts job-oriented
Detailed bar charts job-oriented
Milestone charts event-oriented
Combined bar and milestone chart
CPM arrow-diagram
PERT network
Next generation
Network-based project management systems will be both activity (job) and event oriented

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FIGURE 23

PERT NETWORK

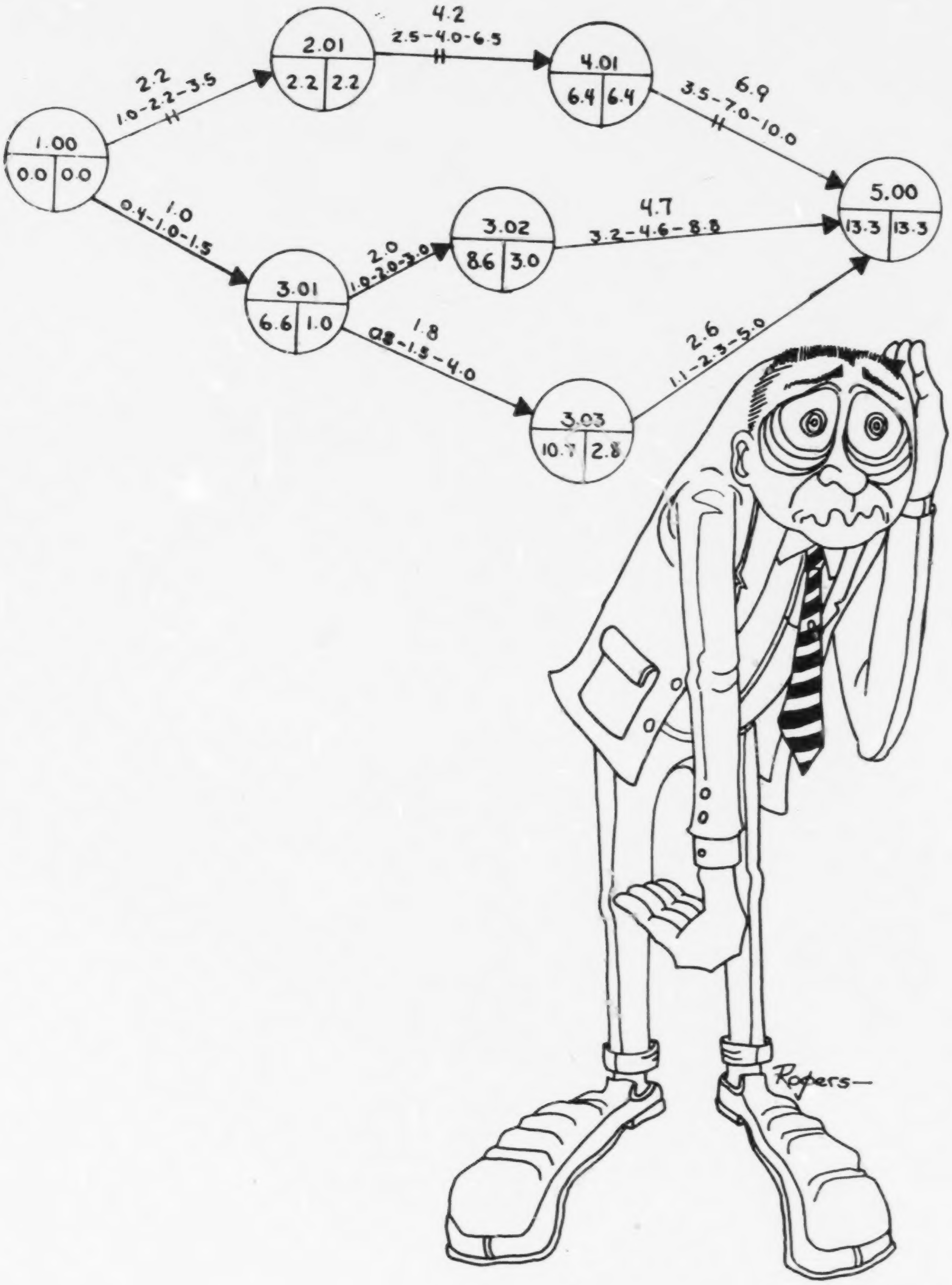
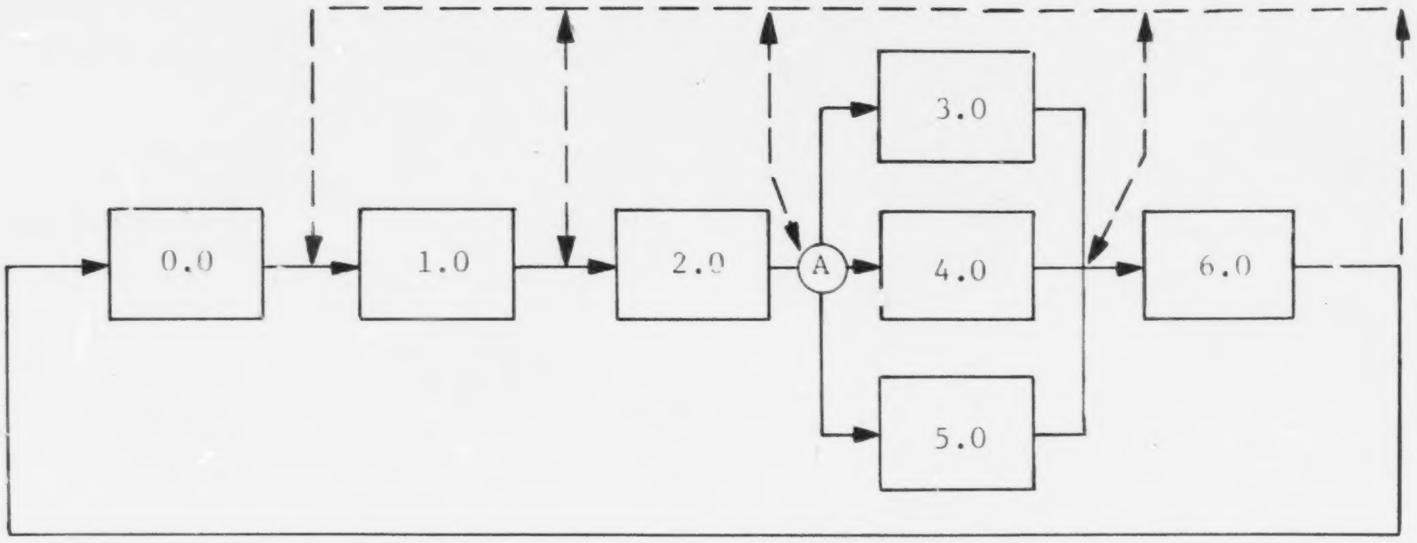
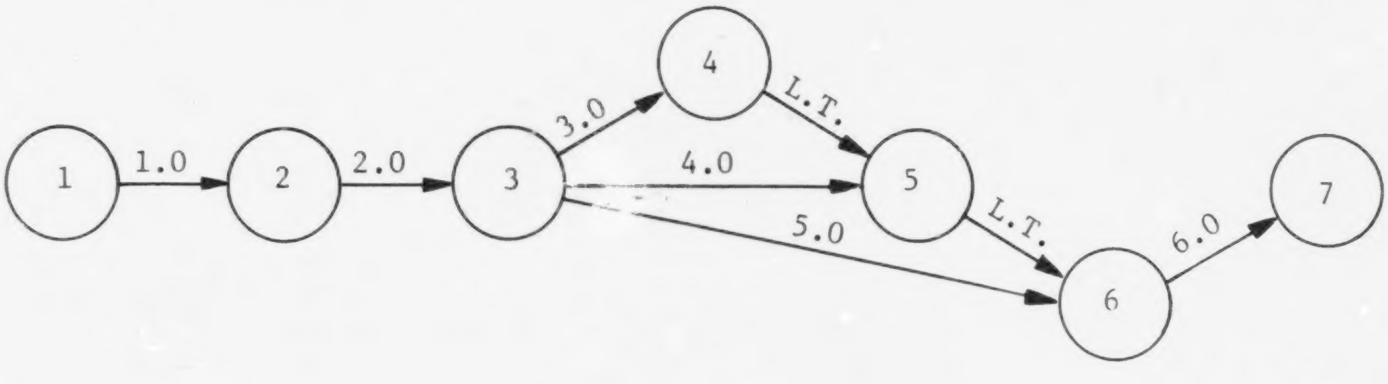

1.00
0.0 0.0
2.2
1.0-2.2-3.5
2.01
2.2 2.2
4.2
2.5-4.0-6.5
4.01
6.4 6.4
6.9
3.5-7.0-10.0
5.00
13.3 13.3
1.0
0.4-1.0-1.5
3.01
6.6 1.0
2.0
1.0-2.0-3.0
3.02
8.6 3.0
4.7
3.2-4.6-8.8
1.8
0.8-1.5-4.0
3.03
10.7 2.8
2.6
1.1-2.3-5.0
Rogers—

FIGURE 24


3.0
0.0
1.0
2.0
A
4.0
6.0
5.0

FIRST-LEVEL FUNCTION FLOW BLOCK DIAGRAM


4
3.0
L.T.
1
1.0
2
2.0
3
4.0
5
7
5.0
L.T.
6.0
6

FIRST-LEVEL NETWORK FLOW DIAGRAM

FIGURE 25

DECISION TREE FOR COCKTAIL PARTY

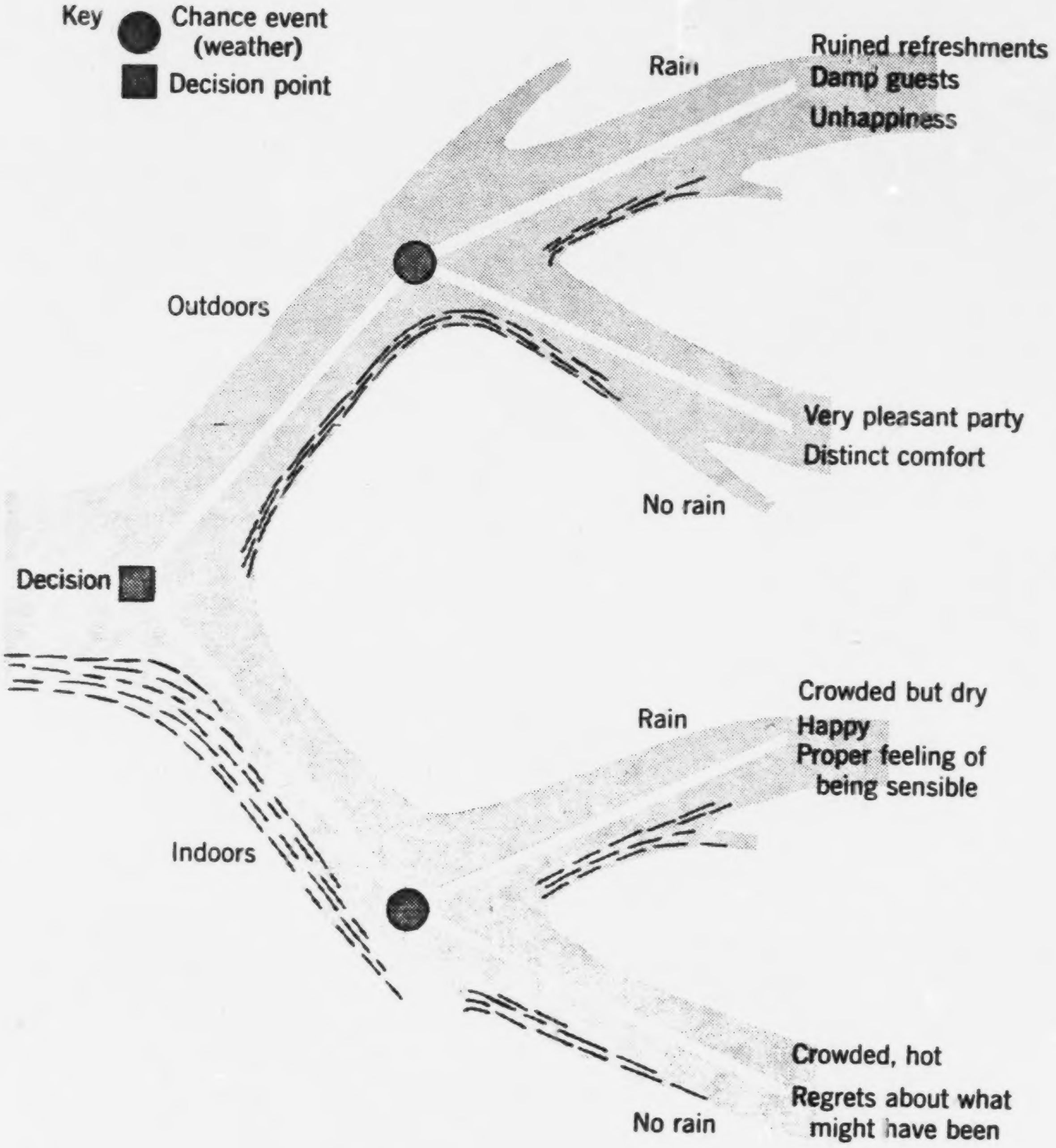

Key
● Chance event (weather)
■ Decision point
Decision
Outdoors
Rain
Ruined refreshments
Damp guests
Unhappiness
No rain
Very pleasant party
Distinct comfort
Indoors
Rain
Crowded but dry
Happy
Proper feeling of being sensible
No rain
Crowded, hot
Regrets about what might have been

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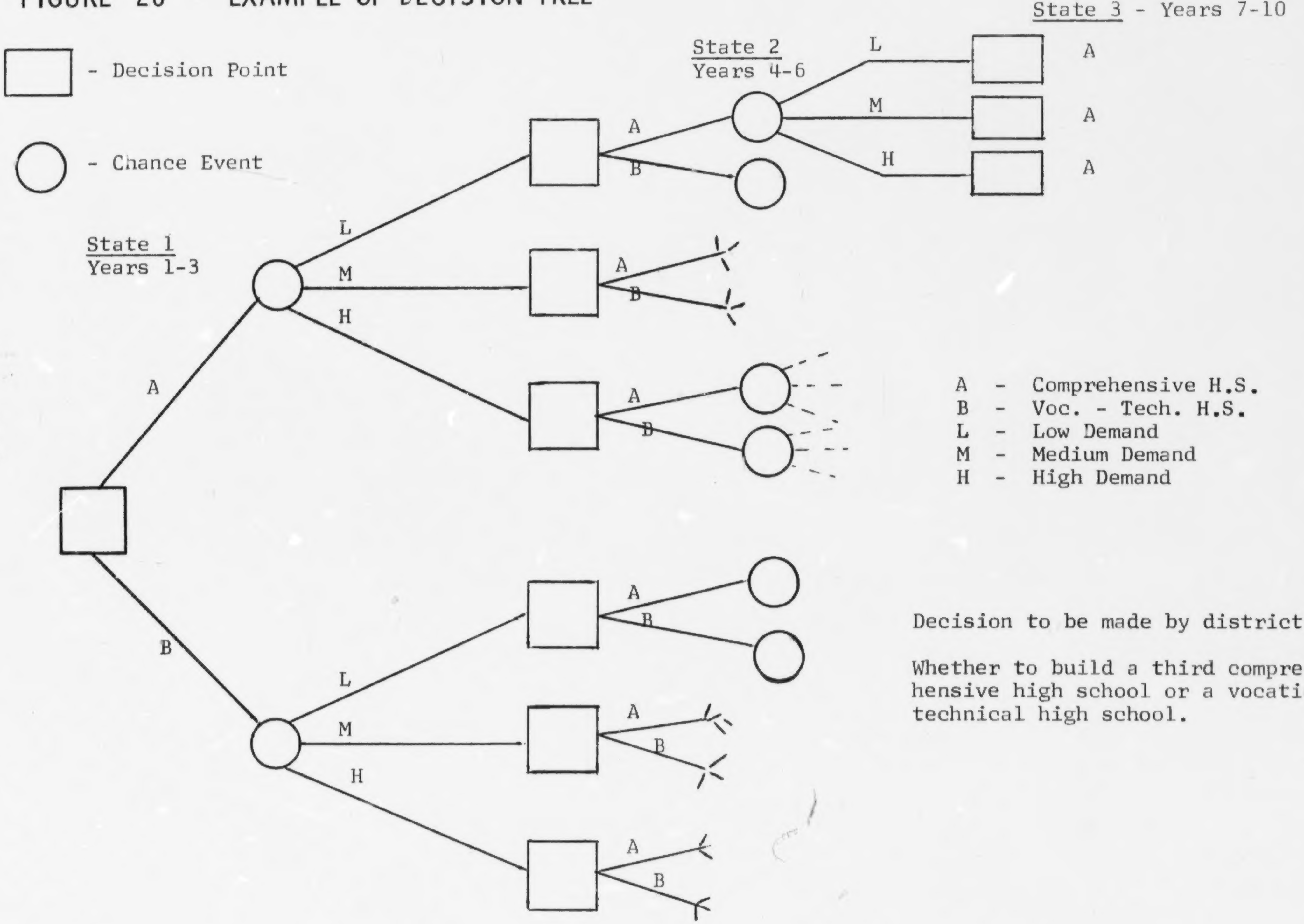
FIGURE 26 - EXAMPLE OF DECISION TREE


- Decision Point
- Chance Event
State 1
Years 1-3
State 2
Years 4-6
State 3 - Years 7-10
A
B
L
M
H

A - Comprehensive H.S.
B - Voc. - Tech. H.S.
L - Low Demand
M - Medium Demand
H - High Demand

Decision to be made by district:

Whether to build a third comprehensive high school or a vocational-technical high school.

FIGURE 27 - BRANCH OF A FAULT TREE

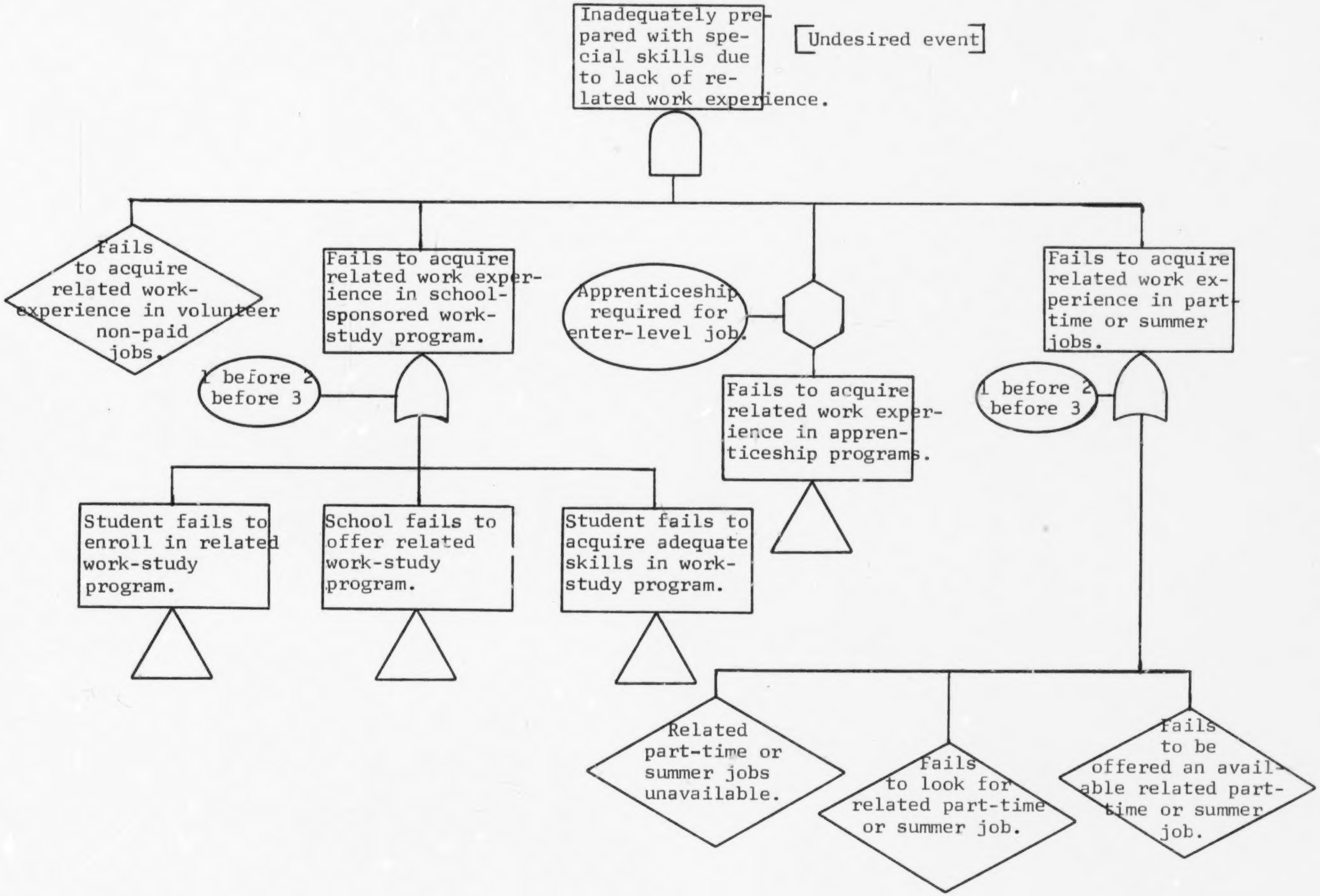

Inadequately prepared with special skills due to lack of related work experience.
Undesired event
Fails to acquire related work-experience in volunteer non-paid jobs.
Fails to acquire related work experience in school-sponsored work-study program.
1 before 2 before 3
Apprenticeship required for enter-level job.
Fails to acquire related work experience in apprenticeship programs.
Fails to acquire related work experience in part-time or summer jobs.
1 before 2 before 3
Student fails to enroll in related work-study program.
School fails to offer related work-study program.
Student fails to acquire adequate skills in work-study program.
Related part-time or summer jobs unavailable.
Fails to look for related part-time or summer job.
Fails to be offered an available related part-time or summer job.

FIGURE 28 - THE SYSTEMS APPROACH AND FAULT TREE ANALYSIS

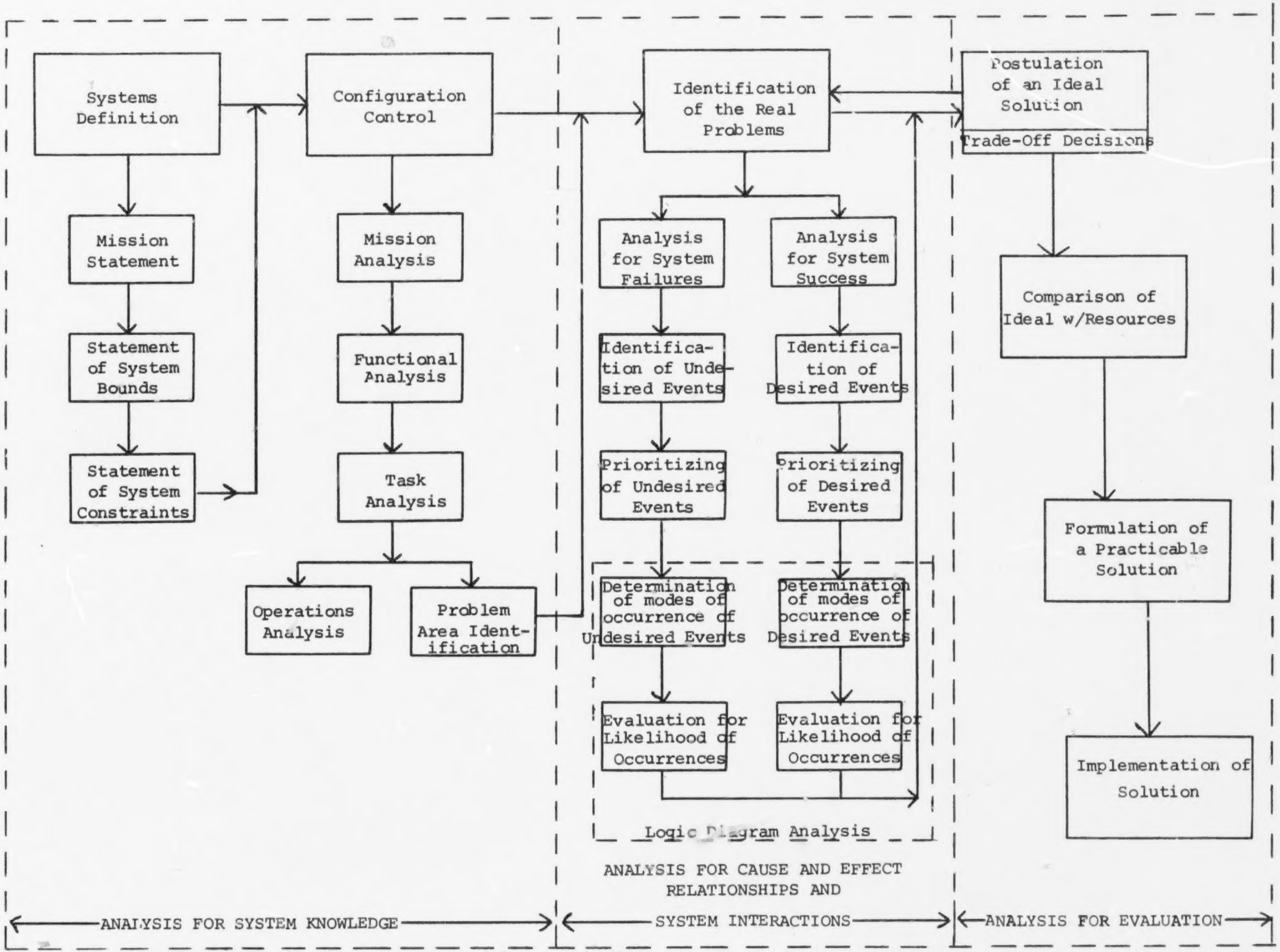

Systems Definition
Mission Statement
Statement of System Bounds
Statement of System Constraints
Configuration Control
Mission Analysis
Functional Analysis
Task Analysis
Operations Analysis
Problem Area Identification
Identification of the Real Problems
Analysis for System Failures
Analysis for System Success
Identification of Undesired Events
Identification of Desired Events
Prioritizing of Undesired Events
Prioritizing of Desired Events
Determination of modes of occurrence of Undesired Events
Determination of modes of occurrence of Desired Events
Evaluation for Likelihood of Occurrences
Evaluation for Likelihood of Occurrences
Logic Diagram Analysis
ANALYSIS FOR CAUSE AND EFFECT RELATIONSHIPS AND
Postulation of an Ideal Solution
Trade-Off Decisions
Comparison of Ideal w/Resources
Formulation of a Practicable Solution
Implementation of Solution
ANALYSIS FOR SYSTEM KNOWLEDGE
SYSTEM INTERACTIONS
ANALYSIS FOR EVALUATION

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FIGURE 29

MODEL OF INFORMATION SYSTEMS FOR DECISION MAKING

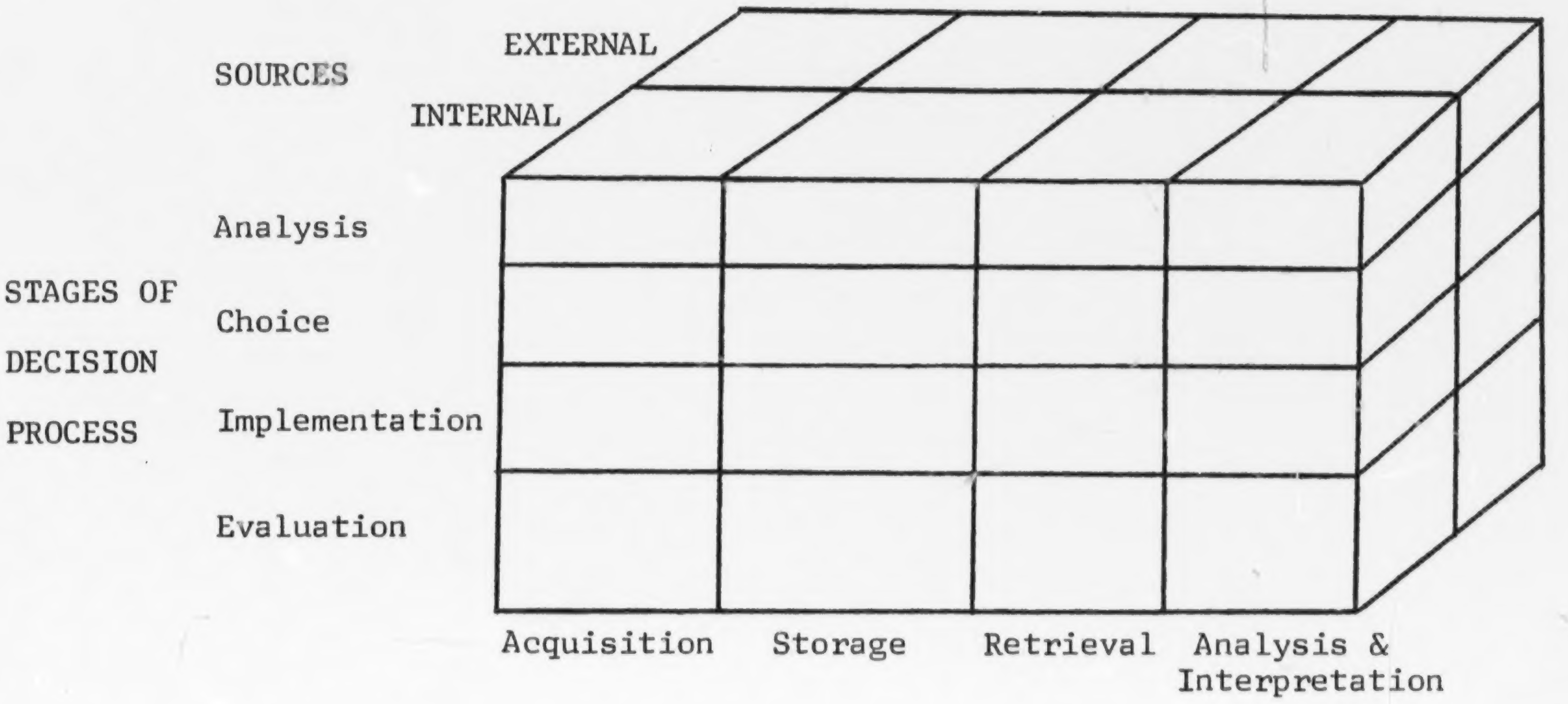

SOURCES
EXTERNAL
INTERNAL
STAGES OF
DECISION
PROCESS
Analysis
Choice
Implementation
Evaluation
Acquisition
Storage
Retrieval
Analysis &
Interpretation

FIGURE 30

RELATIONSHIP BETWEEN AN EDUCATIONAL SYSTEM, MIS, AND THE EDUCATIONAL ENVIRONMENT

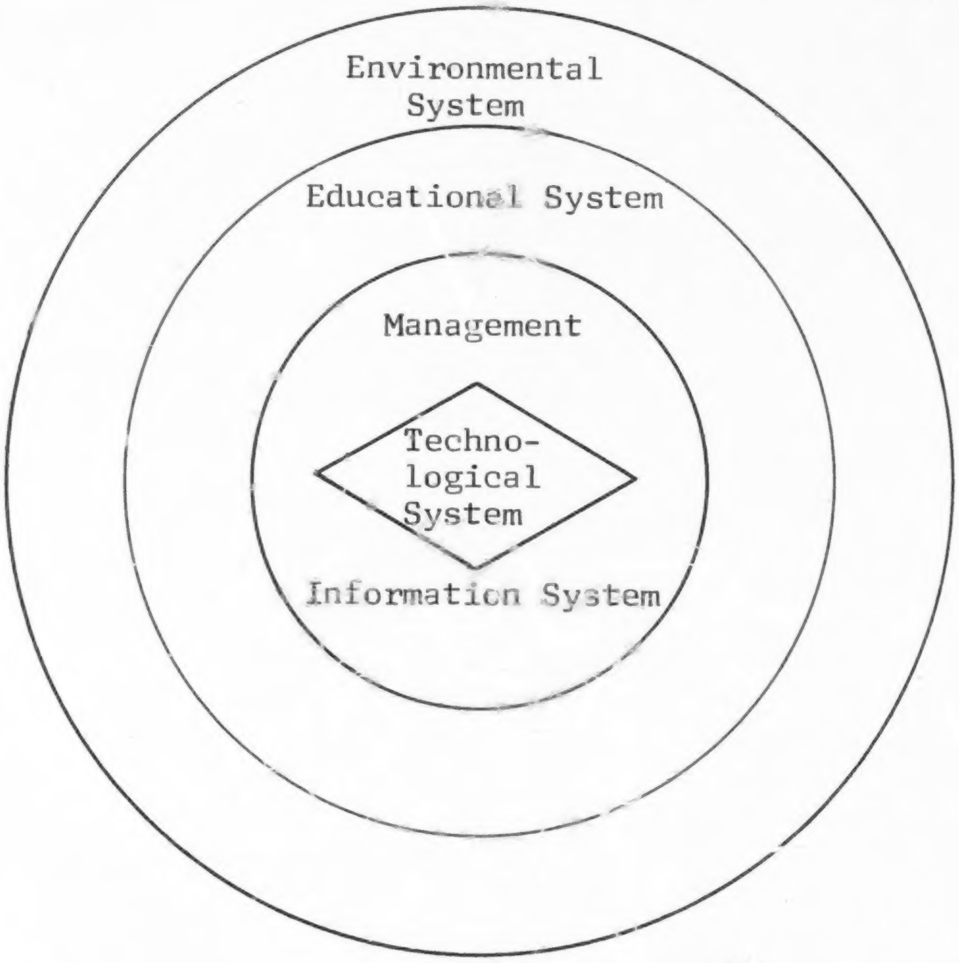
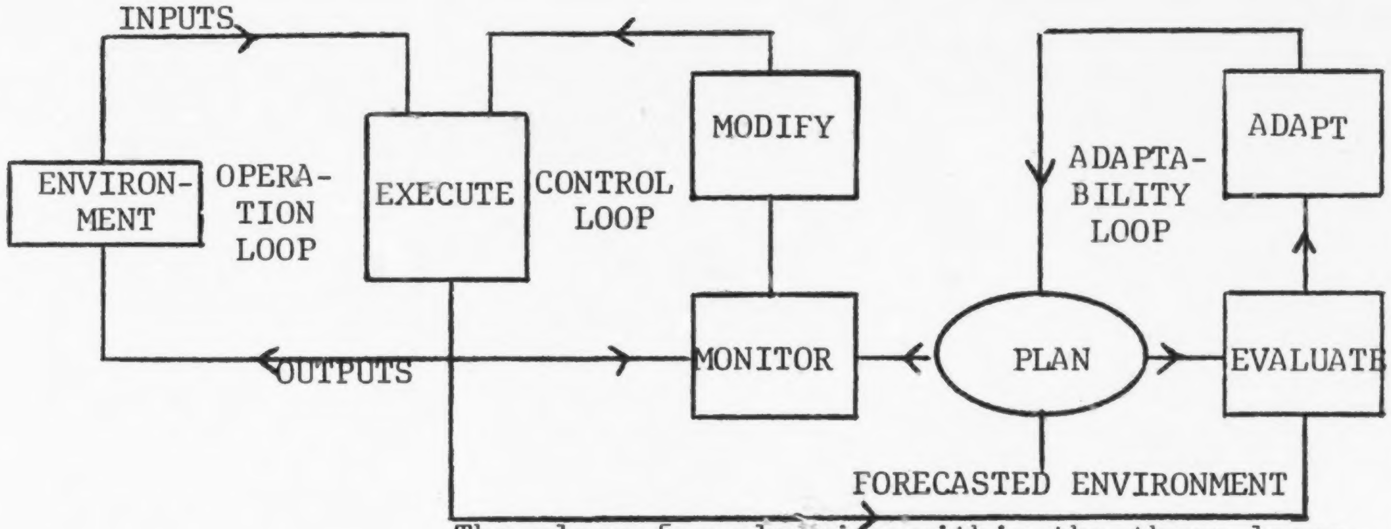

Environmental System
Educational System
Management
Technological System
Information System

FIGURE 31

THE THREE LOOPS OF THE EDUCATION SYSTEM


INPUTS
ENVIRON-MENT
OPERA-TION LOOP
EXECUTE
CONTROL LOOP
MODIFY
MONITOR
OUTPUTS
PLAN
ADAPTA-BILITY LOOP
ADAPT
EVALUATE
FORECASTED ENVIRONMENT

The place for planning within the three loops.

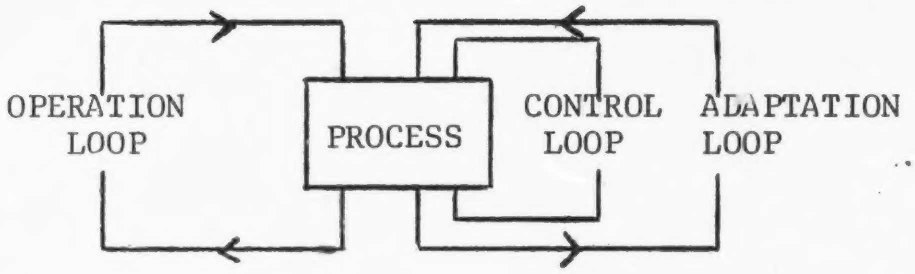

OPERATION LOOP
PROCESS
CONTROL LOOP
ADAPTATION LOOP

FIGURE 32

THE SEQUENCE OF DEVELOPMENT PHASES

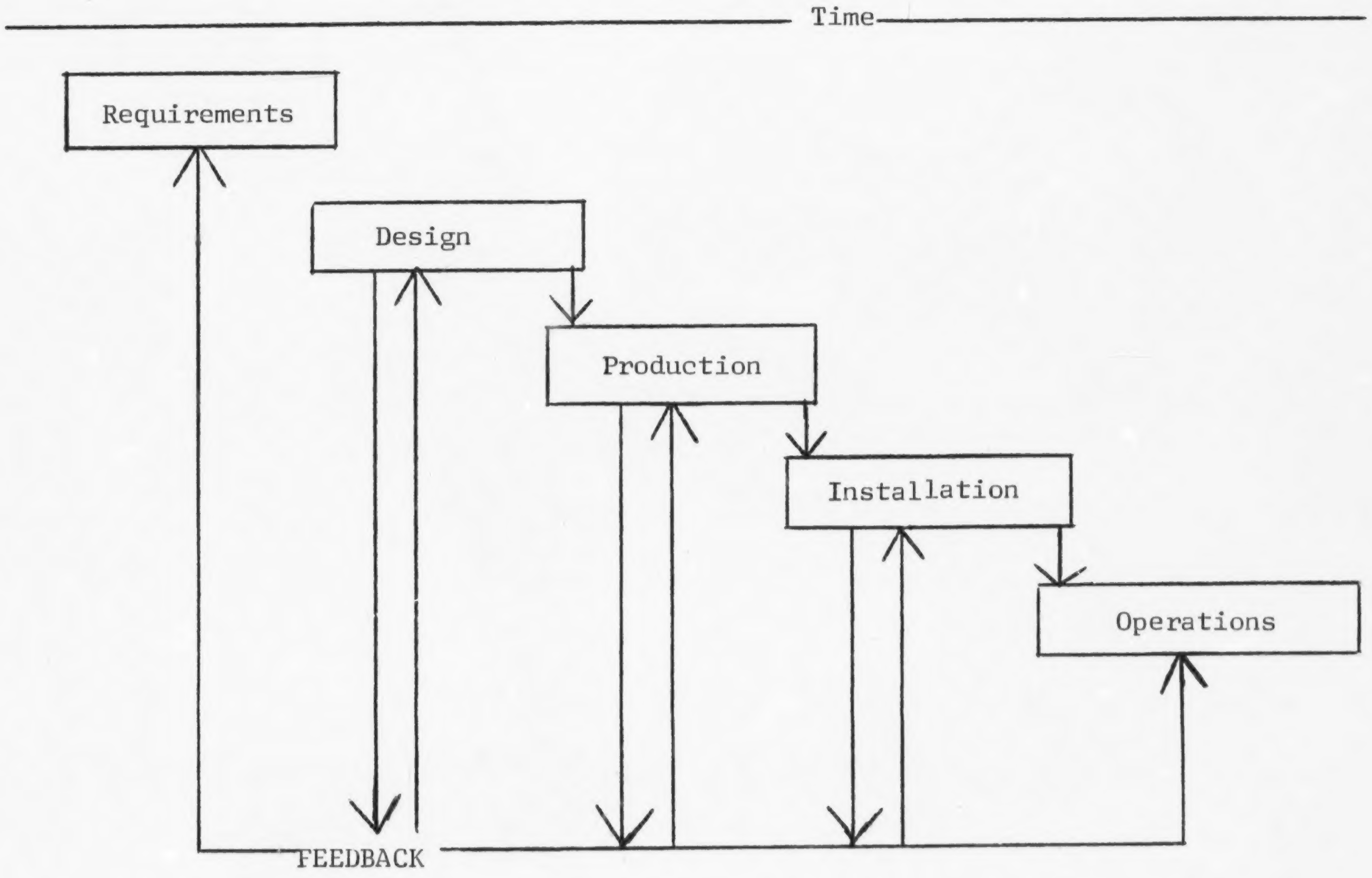

Time
Requirements
Design
Production
Installation
Operations
FEEDBACK

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FIGURE 33

A FUNCTION FLOW MODEL OF ORGANIZATIONAL POLICY DECISION MAKING

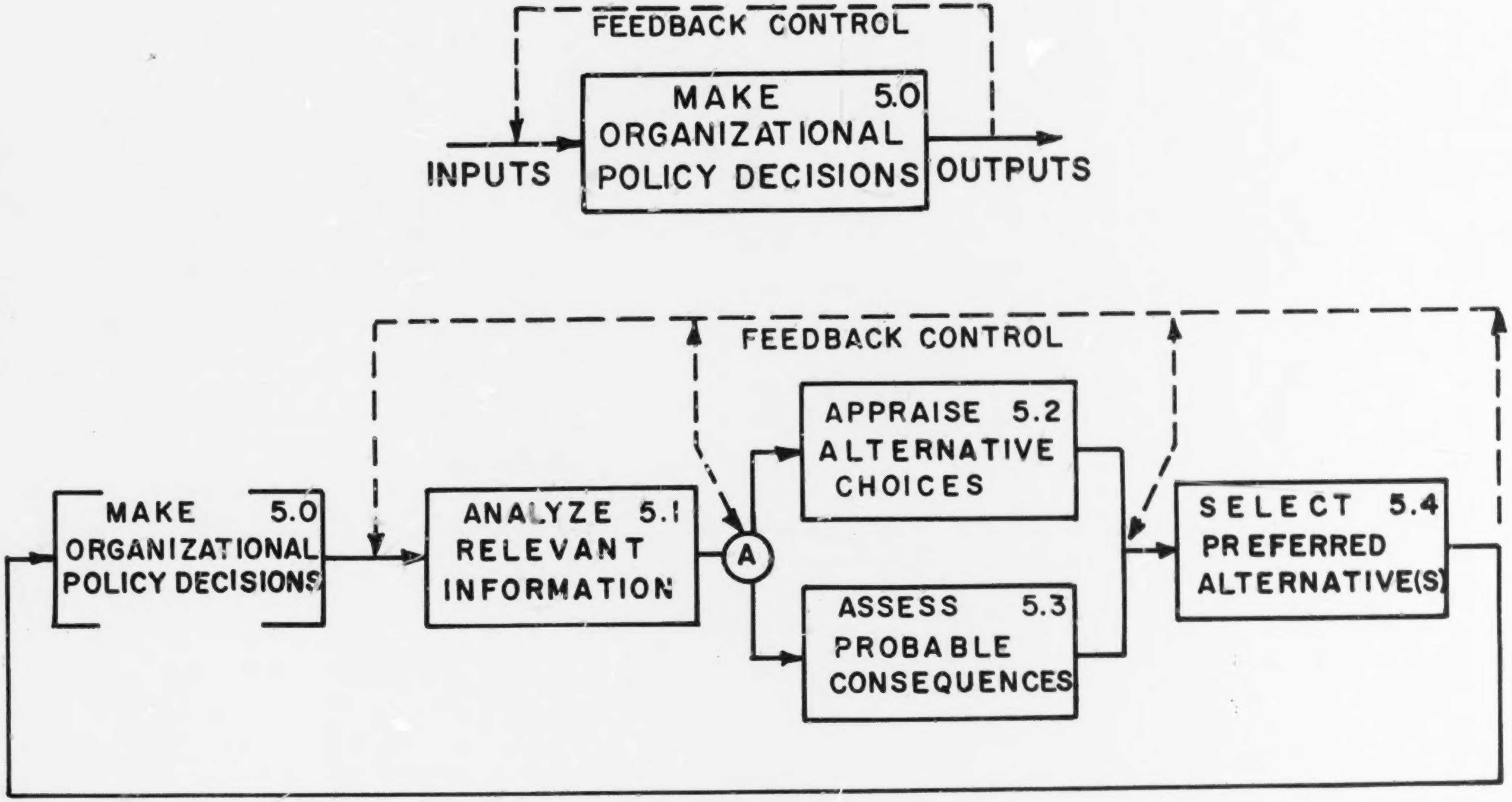
FEEDBACK CONTROL
MAKE 5.0 ORGANIZATIONAL POLICY DECISIONS
INPUTS
OUTPUTS
FEEDBACK CONTROL
MAKE 5.0 ORGANIZATIONAL POLICY DECISIONS
ANALYZE 5.1 RELEVANT INFORMATION
A
APPRAISE 5.2 ALTERNATIVE CHOICES
ASSESS 5.3 PROBABLE CONSEQUENCES
SELECT 5.4 PREFERRED ALTERNATIVE(S)

FIGURE 34 - A REPRESENTATION OF THE SYSTEM DESIGN PROCESS

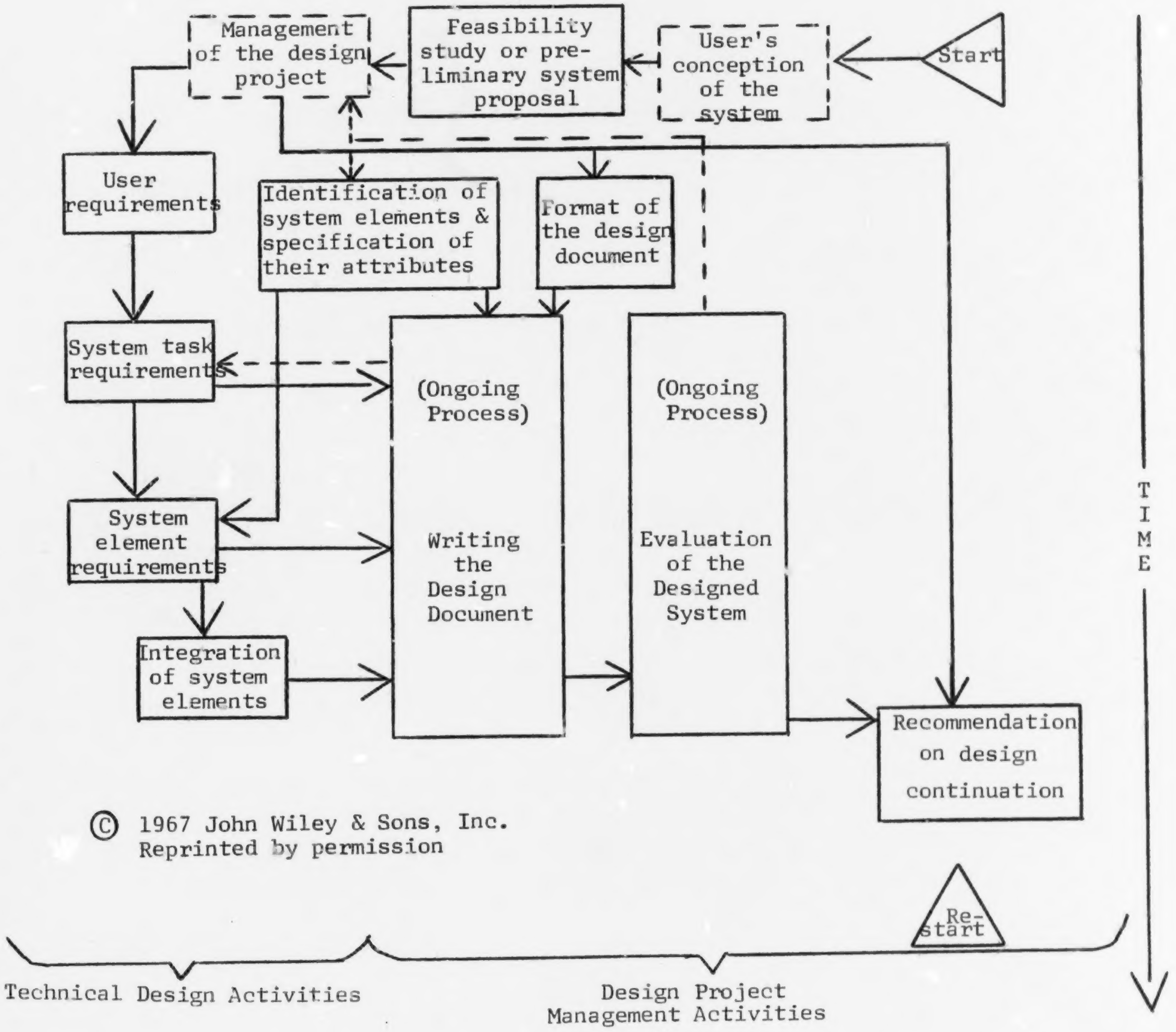
Start
User's conception of the system
Feasibility study or preliminary system proposal
Management of the design project
User requirements
Identification of system elements & specification of their attributes
Format of the design document
System task requirements
(Ongoing Process)
Writing the Design Document
(Ongoing Process)
Evaluation of the Designed System
System element requirements
Integration of system elements
Recommendation on design continuation
Re-start
TIME
Technical Design Activities
Design Project Management Activities

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FIGURE 35

EXECUTIVE INFORMATION SYSTEMS	A SYSTEM FOR EDUCATIONAL ADMINISTRATION

SYSTEM SEGMENTS - OPTION A

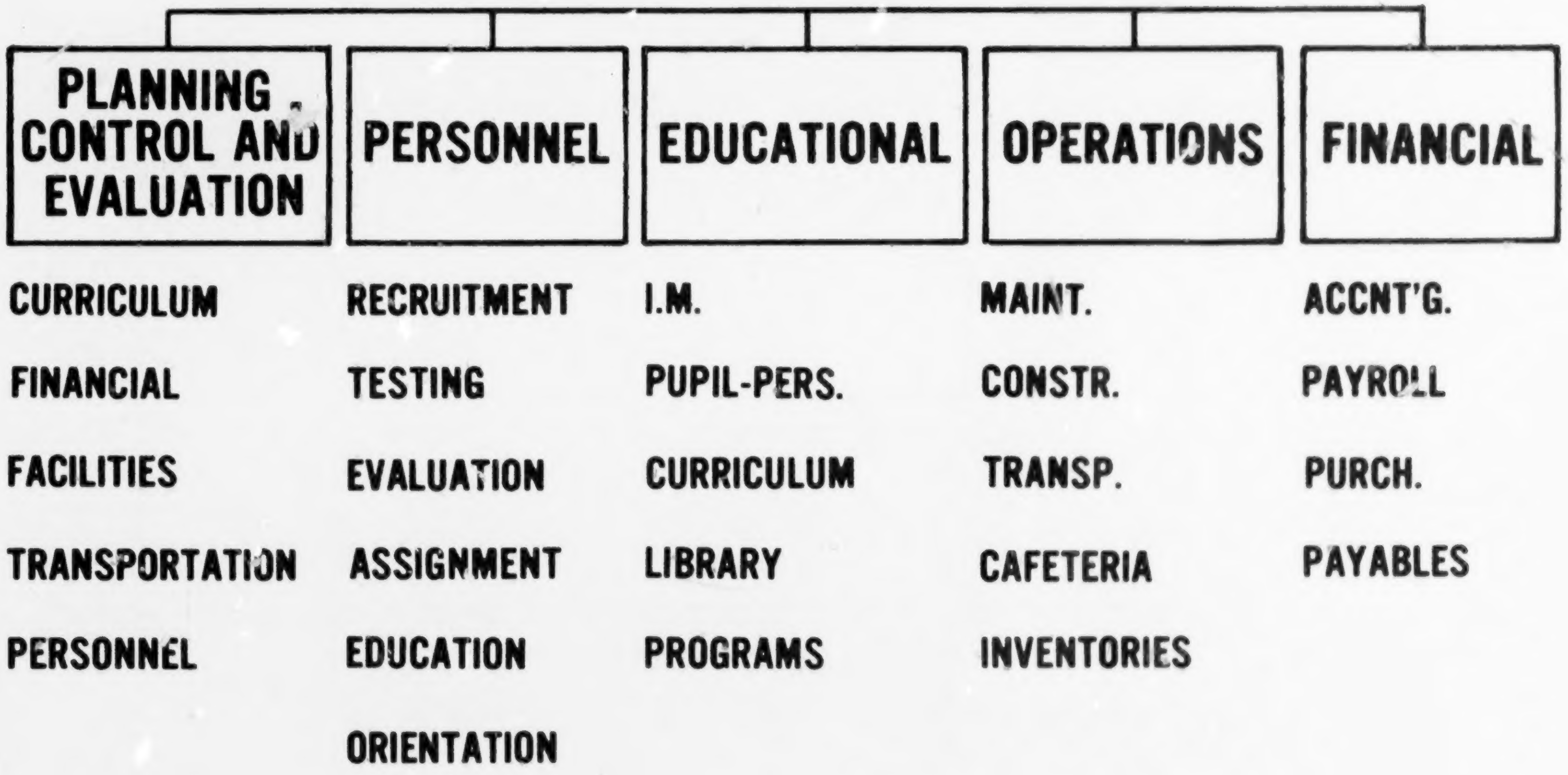

PLANNING CONTROL AND EVALUATION
CURRICULUM
FINANCIAL
FACILITIES
TRANSPORTATION
PERSONNEL
PERSONNEL
RECRUITMENT
TESTING
EVALUATION
ASSIGNMENT
EDUCATION
ORIENTATION
EDUCATIONAL
I.M.
PUPIL-PERS.
CURRICULUM
LIBRARY
PROGRAMS
OPERATIONS
MAINT.
CONSTR.
TRANSP.
CAFETERIA
INVENTORIES
FINANCIAL
ACCNT'G.
PAYROLL
PURCH.
PAYABLES

FIGURE 36

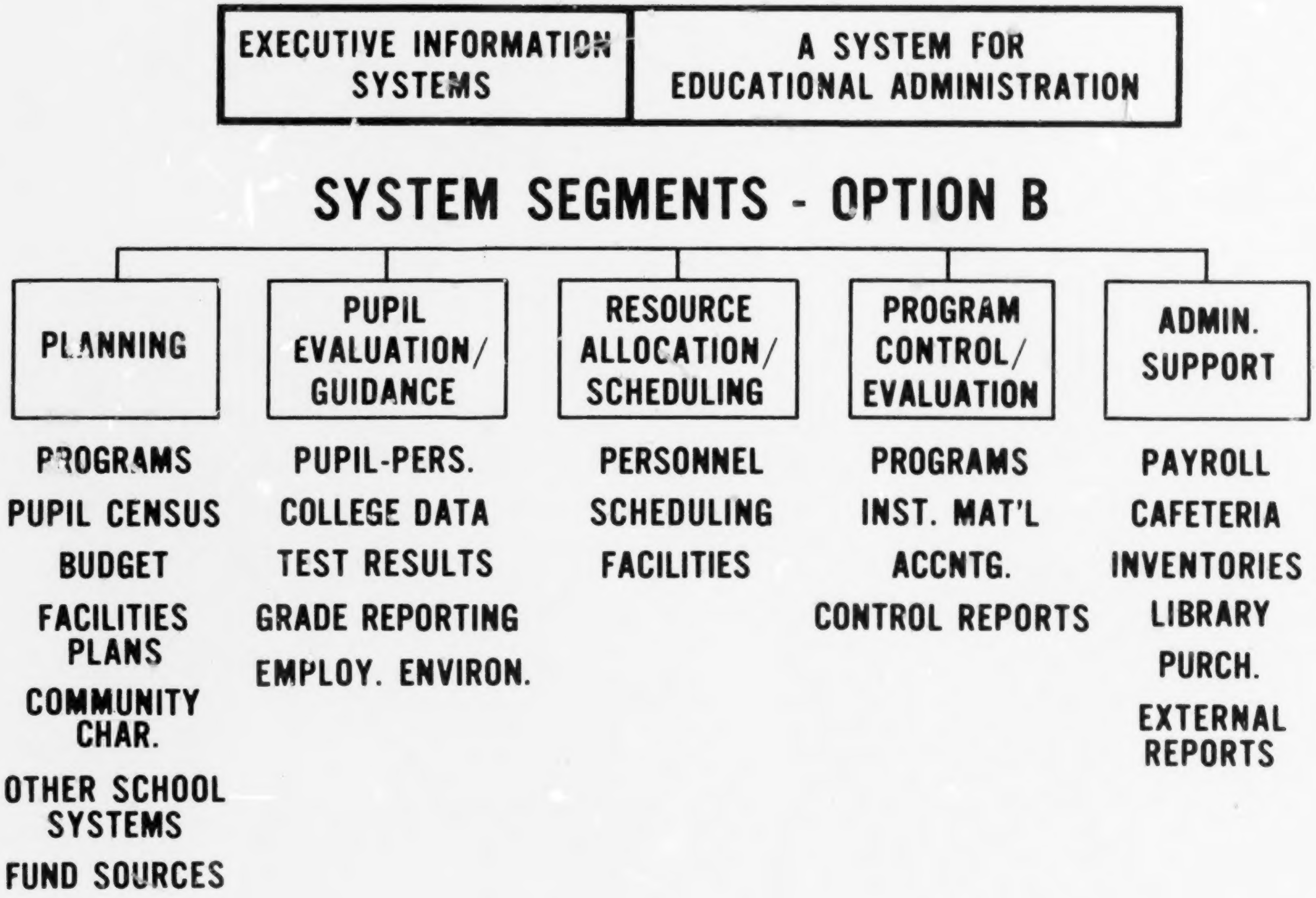

EXECUTIVE INFORMATION SYSTEMS
A SYSTEM FOR EDUCATIONAL ADMINISTRATION
SYSTEM SEGMENTS - OPTION B
PLANNING
PROGRAMS
PUPIL CENSUS
BUDGET
FACILITIES PLANS
COMMUNITY CHAR.
OTHER SCHOOL SYSTEMS
FUND SOURCES
PUPIL EVALUATION/ GUIDANCE
PUPIL-PERS.
COLLEGE DATA
TEST RESULTS
GRADE REPORTING
EMPLOY. ENVIRON.
RESOURCE ALLOCATION/ SCHEDULING
PERSONNEL
SCHEDULING
FACILITIES
PROGRAM CONTROL/ EVALUATION
PROGRAMS
INST. MAT'L
ACCNTG.
CONTROL REPORTS
ADMIN. SUPPORT
PAYROLL
CAFETERIA
INVENTORIES
LIBRARY
PURCH.
EXTERNAL REPORTS

FIGURE 37

AN ADAPTIVE FRAMEWORK FOR EDUCATIONAL DECISION MAKING

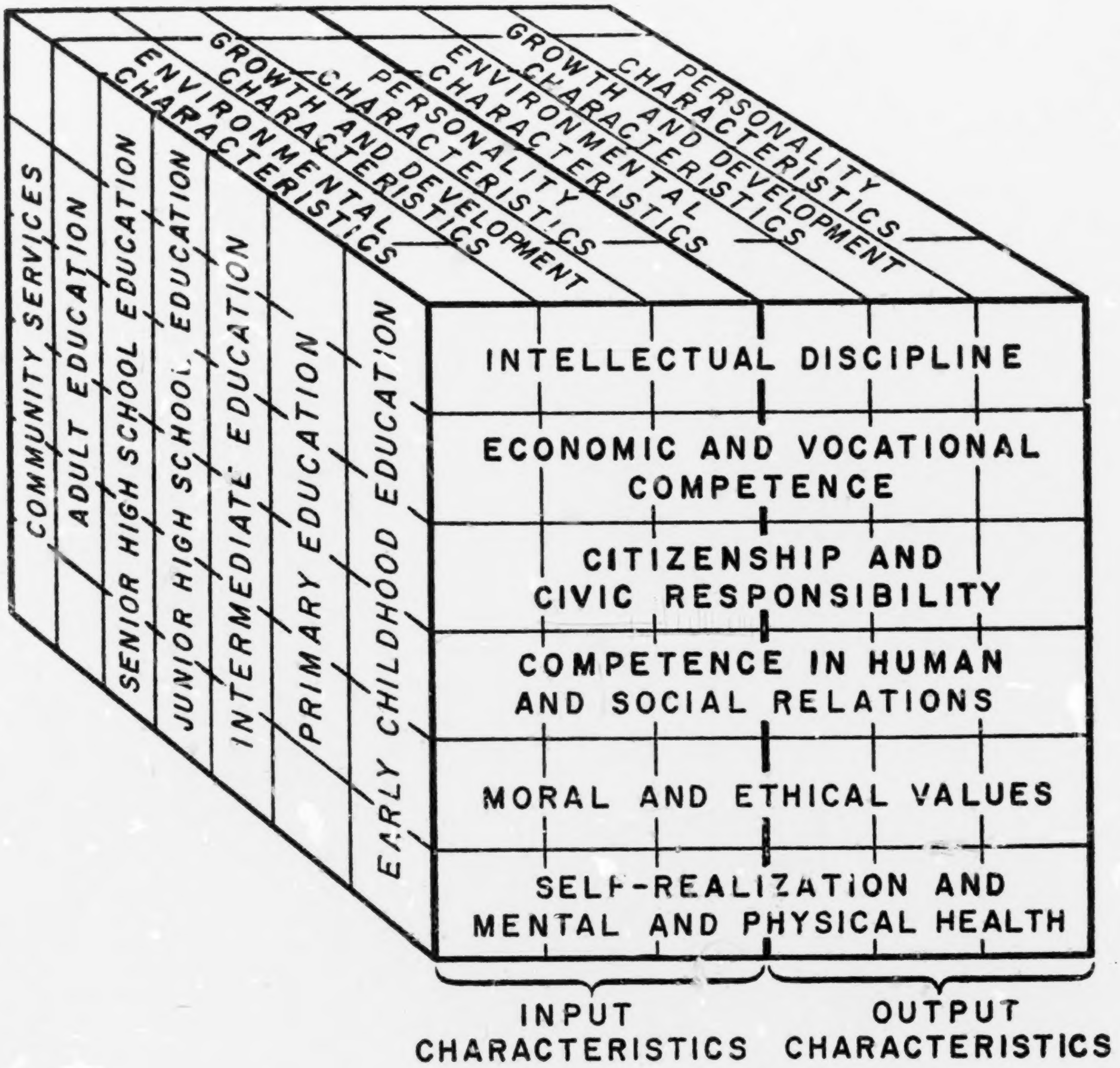
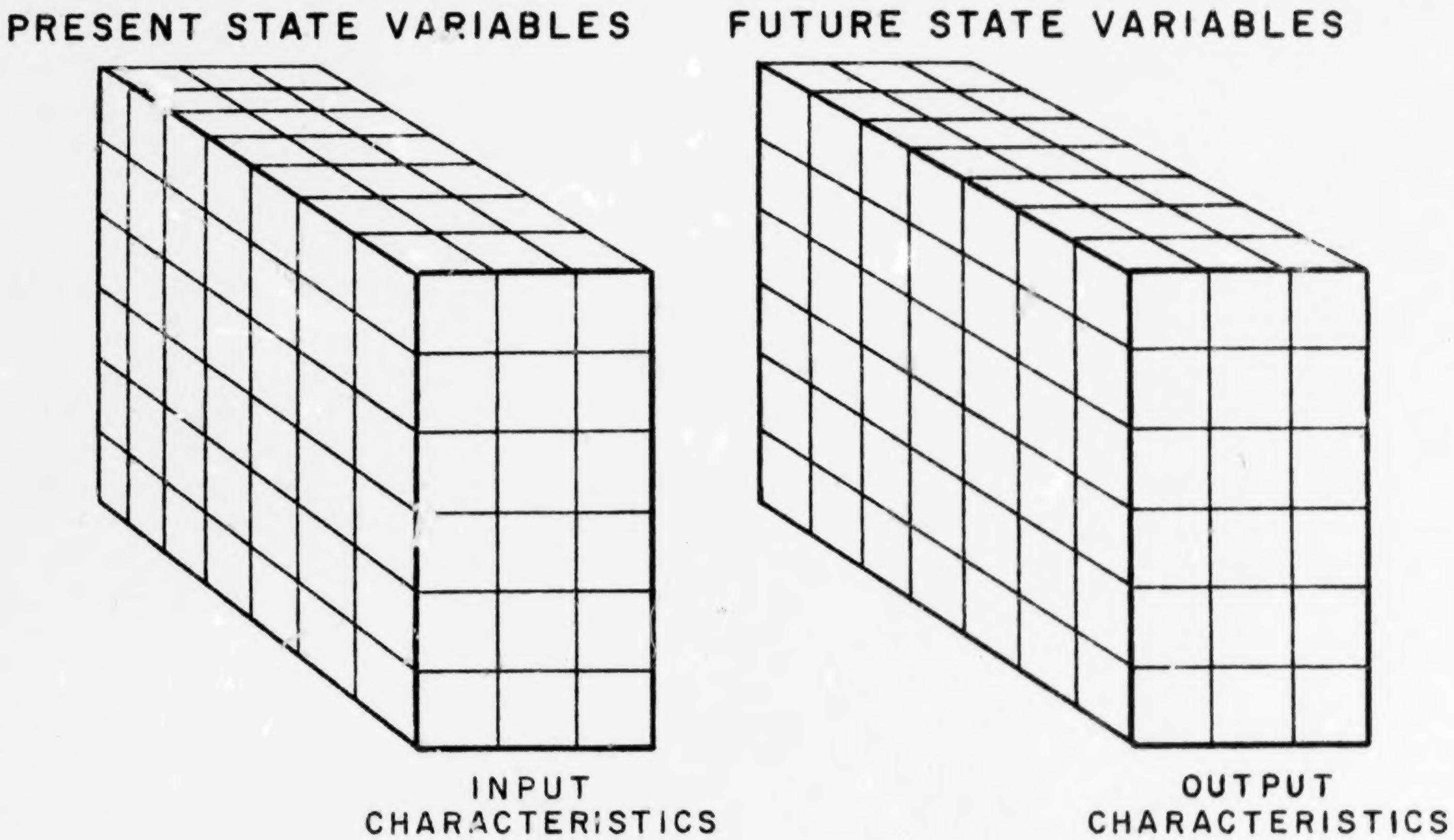

PERSONALITY CHARACTERISTICS
GROWTH AND DEVELOPMENT CHARACTERISTICS
ENVIRONMENTAL CHARACTERISTICS
PERSONALITY CHARACTERISTICS
GROWTH AND DEVELOPMENT CHARACTERISTICS
ENVIRONMENTAL CHARACTERISTICS
COMMUNITY SERVICES
ADULT EDUCATION
SENIOR HIGH SCHOOL EDUCATION
JUNIOR HIGH SCHOOL EDUCATION
INTERMEDIATE EDUCATION
PRIMARY EDUCATION
EARLY CHILDHOOD EDUCATION
INTELLECTUAL DISCIPLINE
ECONOMIC AND VOCATIONAL COMPETENCE
CITIZENSHIP AND CIVIC RESPONSIBILITY
COMPETENCE IN HUMAN AND SOCIAL RELATIONS
MORAL AND ETHICAL VALUES
SELF-REALIZATION AND MENTAL AND PHYSICAL HEALTH
INPUT CHARACTERISTICS
OUTPUT CHARACTERISTICS

FIGURE 38

APPLICATION OF THE ADAPTIVE FRAMEWORK IN SUPPORT OF CHANGE AND/OR RENEWAL DECISIONS


PRESENT STATE VARIABLES
FUTURE STATE VARIABLES
INPUT CHARACTERISTICS
OUTPUT CHARACTERISTICS

CHANGE AND/OR RENEWAL CHARACTERISTICS INCLUDE:

ISSUES • ALTERNATIVES • CONSEQUENCES • PROBLEMS

GOALS AND OBJECTIVES • PLANS AND STRATEGIES • PROCEDURES

FIGURE 3 9

THE STEPS IN CURRICULUM DESIGN APPLY PROCESSES OF ANALYSIS SIMILAR TO SYSTEMS ANALYSIS

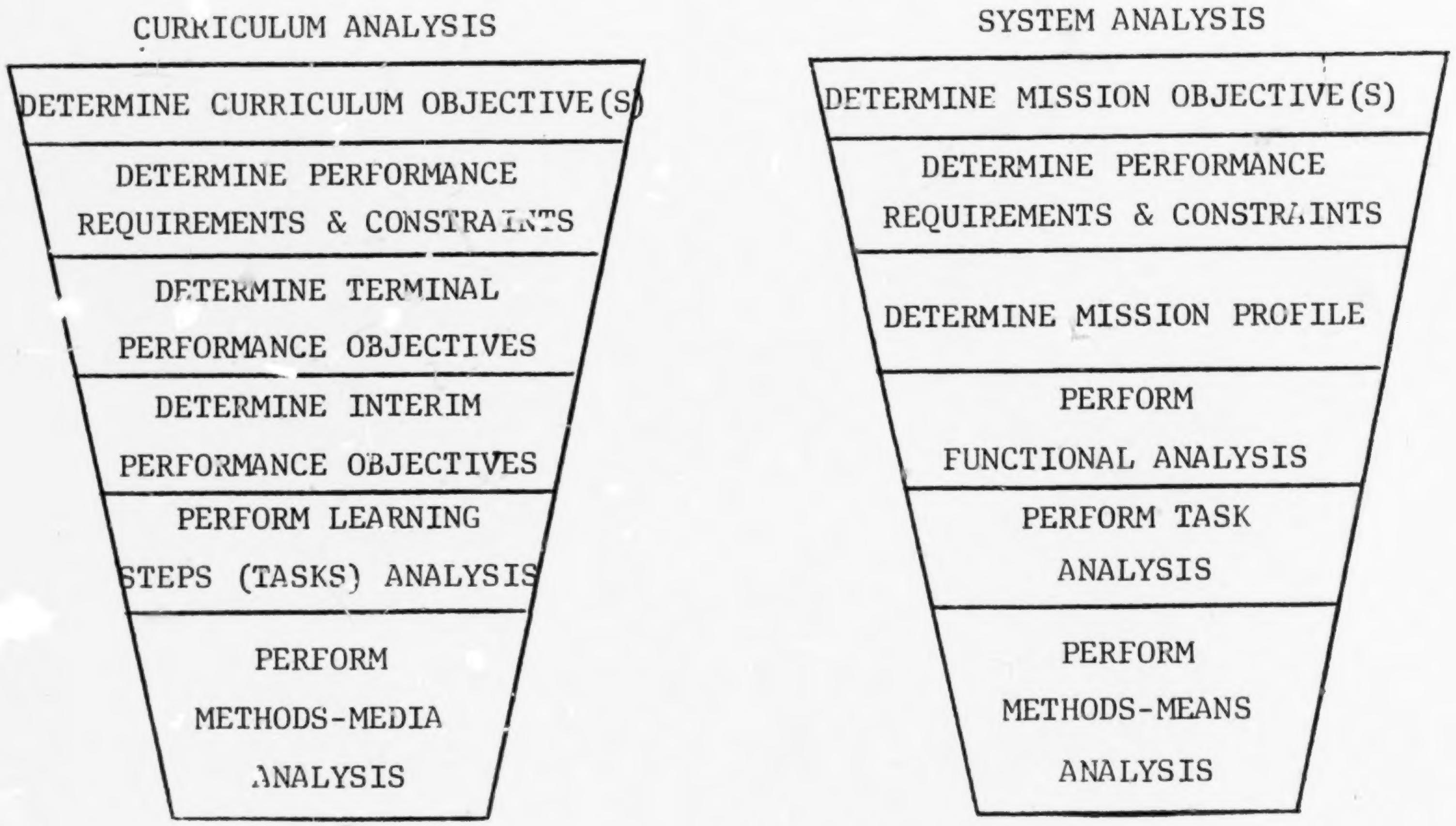

CURRICULUM ANALYSIS
DETERMINE CURRICULUM OBJECTIVE(S)
DETERMINE PERFORMANCE REQUIREMENTS & CONSTRAINTS
DETERMINE TERMINAL PERFORMANCE OBJECTIVES
DETERMINE INTERIM PERFORMANCE OBJECTIVES
PERFORM LEARNING STEPS (TASKS) ANALYSIS
PERFORM METHODS-MEDIA ANALYSIS
SYSTEM ANALYSIS
DETERMINE MISSION OBJECTIVE(S)
DETERMINE PERFORMANCE REQUIREMENTS & CONSTRAINTS
DETERMINE MISSION PROFILE
PERFORM FUNCTIONAL ANALYSIS
PERFORM TASK ANALYSIS
PERFORM METHODS-MEANS ANALYSIS

FIGURE 40

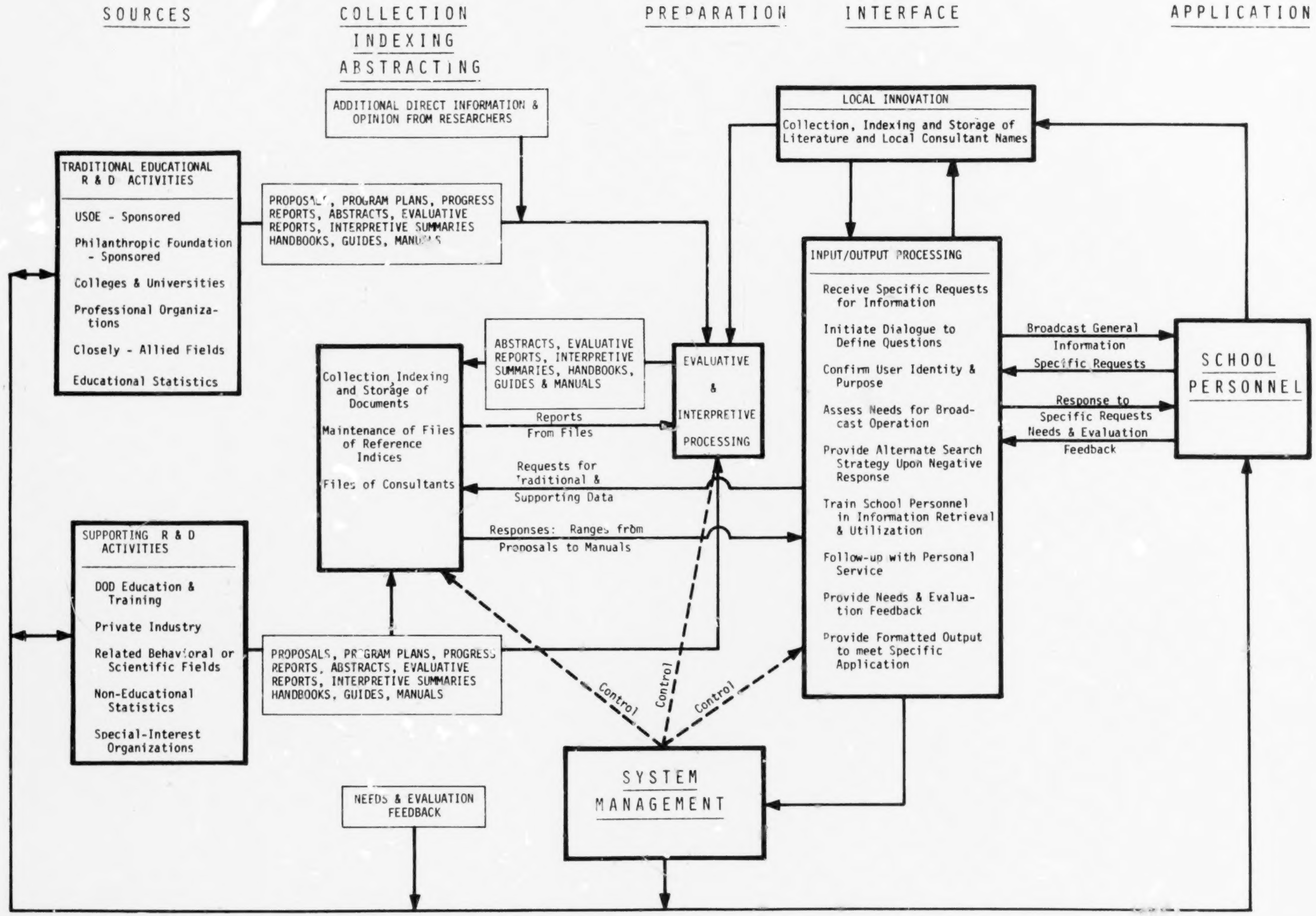

SOURCES
COLLECTION
INDEXING
ABSTRACTING
PREPARATION
INTERFACE
APPLICATION
ADDITIONAL DIRECT INFORMATION & OPINION FROM RESEARCHERS
LOCAL INNOVATION
Collection, Indexing and Storage of Literature and Local Consultant Names
TRADITIONAL EDUCATIONAL R & D ACTIVITIES
USOE - Sponsored
Philanthropic Foundation - Sponsored
Colleges & Universities
Professional Organizations
Closely - Allied Fields
Educational Statistics
PROPOSALS, PROGRAM PLANS, PROGRESS REPORTS, ABSTRACTS, EVALUATIVE REPORTS, INTERPRETIVE SUMMARIES HANDBOOKS, GUIDES, MANUALS
INPUT/OUTPUT PROCESSING
Receive Specific Requests for Information
Initiate Dialogue to Define Questions
Confirm User Identity & Purpose
Assess Needs for Broadcast Operation
Provide Alternate Search Strategy Upon Negative Response
Train School Personnel in Information Retrieval & Utilization
Follow-up with Personal Service
Provide Needs & Evaluation Feedback
Provide Formatted Output to meet Specific Application
Broadcast General Information
Specific Requests
Response to Specific Requests
Needs & Evaluation Feedback
SCHOOL PERSONNEL
ABSTRACTS, EVALUATIVE REPORTS, INTERPRETIVE SUMMARIES, HANDBOOKS, GUIDES & MANUALS
EVALUATIVE & INTERPRETIVE PROCESSING
Collection Indexing and Storage of Documents
Maintenance of Files of Reference Indices
Files of Consultants
Reports From Files
Requests for Traditional & Supporting Data
Responses: Ranges from Proposals to Manuals
SUPPORTING R & D ACTIVITIES
DOD Education & Training
Private Industry
Related Behavioral or Scientific Fields
Non-Educational Statistics
Special-Interest Organizations
PROPOSALS, PROGRAM PLANS, PROGRESS REPORTS, ABSTRACTS, EVALUATIVE REPORTS, INTERPRETIVE SUMMARIES HANDBOOKS, GUIDES, MANUALS
Control
Control
Control
SYSTEM MANAGEMENT
NEEDS & EVALUATION FEEDBACK

FIGURE 41

VALUE OF USING THE COMPUTER IN SCHOOL ADMINISTRATION

Process	Input Data →	Data Processing →	Reports & Answers →	Decision Making →	Action
Cost	Cost of Input	Cost of Processing	Cost of Report	Cost of Decision	Cost of the Action
Value	None	None	None	None	Value of the Action

↑ Most Educational Data Processing Stops Here!!

↑ The real value of the use of the computer in decision-making does not accrue until this point is reached.